THE DISTRIBUTION OF PELAGIC POLYCHAETES ACROSS THE NORTH PACIFIC

BY

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Pp. 371–492 ; 55 *Text-figures*

27 FEB 1962
PRESENTED

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
ZOOLOGY Vol. 7 No. 9
LONDON : 1962

THE BULLETIN OF THE BRITISH MUSEUM (NATURAL HISTORY), *instituted in* 1949, *is issued in five series corresponding to the Departments of the Museum, and an Historical series.*

Parts will appear at irregular intervals as they become ready. Volumes will contain about three or four hundred pages, and will not necessarily be completed within one calendar year.

This paper is Vol. 7, No. 9 of the Zoological series.

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THE BRITISH MUSEUM

Issued February 1962 *Price Fifty-five Shillings*

THE DISTRIBUTION OF PELAGIC POLYCHAETES ACROSS THE NORTH PACIFIC OCEAN

By NORMAN TEBBLE

THE principal purpose of this report is to examine the extent to which pelagic polychaetes are restricted in their distribution in the North Pacific Ocean at the northern boundary of the Sub-Tropical Zone and the southern boundary of the Sub-Arctic Zone. Previously reported collections from this region have been confined to material from small areas, or from a few stations scattered over the ocean. The essential requirements for such a study, abundant samples from stations made across the major hydrological boundaries of the region, were provided by the collections of the University of California, Scripps Institution of Oceanography, La Jolla, California. It is principally on an examination of these collections that this study is based.

It is a pleasure to record my gratitude to the Royal Society of London for the award of the John Murray Travelling Studentship in 1958 which made possible my visit to the Scripps Institution of Oceanography, and also to that Institution for providing facilities during the first year of study. To Dr. Martin Johnson, Professor of Marine Biology at La Jolla, I am particularly grateful for inviting me to make this report, and for encouragement and criticism throughout its preparation ; other colleagues at Scripps, including Dr. J. A. McGowan and Dr. L. Berner, also provided invaluable advice. Miss Dorothy Tyler was responsible for sorting the plankton samples, and, for her sedulous work, I am very much indebted. Mr. Bob Winsett has prepared the drawings of complete specimens (Text-figs. 4–6, 13, 19, 21–23) and it is a pleasure to pay tribute to his artistic ability. Dr. Warren Wooster and Mr. Bruce Taft provided guidance in the interpretation of hydrological data. At the British Museum (Natural History) the Keeper of Zoology, Dr. F. C. Fraser, has given continual support and encouragement to this work and Miss A. C. Edwards has been very helpful in the preparation of drawings and charts.

MATERIAL AND METHODS

The plankton samples examined in this report were collected by ships of the Scripps Institution of Oceanography on the Trans-Pacific Expedition, 1953 ; Northern Holiday Expedition, 1951 ; Chinook Expedition, 1956 ; and by the Pacific Oceanic Fisheries Investigations of the U.S. Fish and Wild Life Service, Honolulu, *Hugh M. Smith* Cruise 30, 1955. The positions of the stations at which the samples were collected are shown in Text-fig. 1, and the number of samples examined tabulated according to Expedition, Zoogeographical location and depth in Table I.

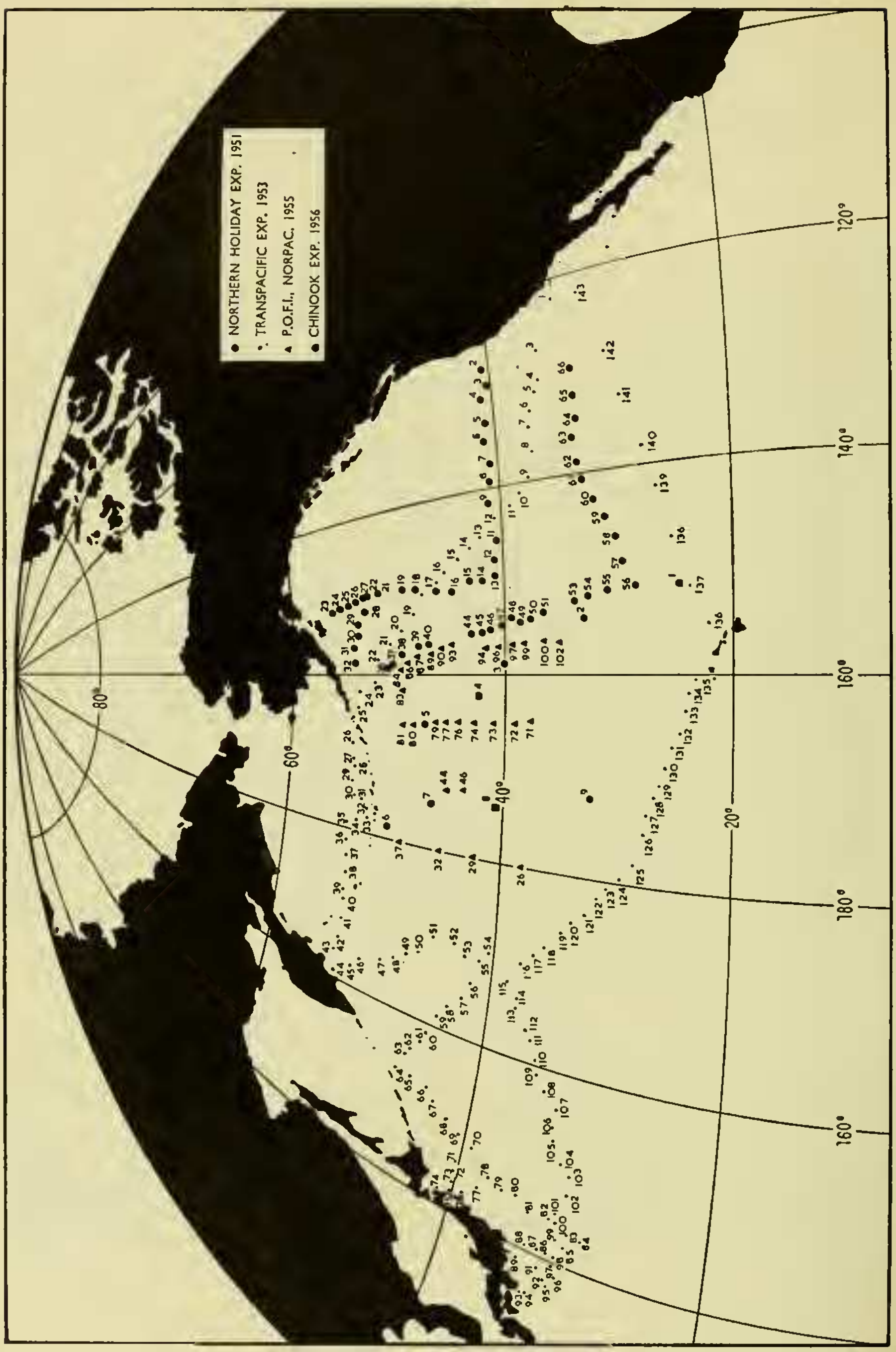

FIG. 1. Chart showing the positions of stations from which plankton samples have been examined.

TABLE I.—*Number of Samples Examined, According to Expedition, Zoogeographical Location and Depth*

Depth of tow (metres)	Sub-Tropical Zone	Transition Zone	Sub-Arctic Zone	Totals
TRANS-PACIFIC EXP.—				
190–0	72	10	52	
Between 530 and 190–0	38	3	11	
Between 1,280 and 530–0	9	2	6	
150–35	0	0	2	
385–75	38	7	30	
720–210 (Mainly 500–300)	18	3	13	
680–495	3	2	2	
850–680	2	0	0	
1,175–525	0	0	1	
Subtotals	180	27	117	324
NORTHERN HOLIDAY EXP.—				
Between 227 and 118–0	31	6	18	55
P.O.F.I. *H. M. S.* CRUISE 30—				
145–0	13	9	6	28
CHINOOK EXP.—				
Between 130 and 85–0	5	4	3	9
Totals	229	45	142	416

These samples represent the material which was sorted for pelagic polychaetes. Both negative and positive results from them are recorded on the distribution maps for the various species except for the maps recording quantitative distribution on which *Hugh M. Smith* cruise 30 results have not been plotted. No details of the amount of water filtered by each net are available for this cruise but this information is available for the other expeditions. Details of number of specimens of all species collected are tabulated in Appendix I, Tables I and II.

Except for the University of Washington collections, which were made with a mid-water trawl, all the samples were collected with 1-metre nets, which have a mesh of 0·65 mm. (29 to the inch) of 30 xxx, silkgrit gauze. This net appears to be most efficient for catching pelagic polychaetes, the majority of which fall within the 5 to 35 mm. size range. Use of this net helps to explain the large number of records made here and by Dales (1957) for species not previously known to occur in abundance. For example, in the South Atlantic collections of *Discovery* from the Tropical and Sub-Tropical Zones (Tebble, 1960), when 1-metre nets were comparatively rarely used and the TYF (with a 2-metre frame and 10–12 meshes to the inch) normally in operation, no catches of *Sagitella kowalewskii* were reported, although it is known to occur there (Friedrich, 1950). In the North Pacific this species has been collected with persistant regularity (Text-fig. 48). On the other hand there were many more records for the larger *T. nisseni* (up to 70 mm. in length) from *Discovery* collections, than from the North Pacific, because it was more easily caught by the larger net. Nevertheless, for most pelagic polychaetes measuring less than 35 m. long, the 1-metre net appears to provide a better chance of catching a larger number of species.

This question of net efficiency is a debatable point (it is clearly associated with comparative abundance, type of tow, etc.) yet its importance cannot be overlooked, and the success of the Scripps Institution's Expeditions and of CCOFI (Dales, 1957) in catching pelagic polychaetes with the 1-metre net warrants comment.

Details of how the nets were operated on the Trans-Pacific Expedition, in both open and closed tows, have been given by McGowan (1960).

The collections made by the University of Washington were kindly provided by Mr. William Aron whose research is supported by the National Science Foundation and by the Office of Naval Research, Contract 477 (10). The mesh size of the nets used in making these collections and the method of towing is such that the smaller beasts are bound to be squeezed out of the net. For this reason I have not plotted the negative records from this collection on the distribution maps in this paper. The positive records, however, have been plotted, and details are tabulated in Appendix I, Table III.

Hereafter the report is divided into four sections :

(1) *Hydrological Environment*, a brief account only ; the reader is referred to the relevant parts of Chapter XV, in Sverdrup *et al.*, 1946 for greater detail ;

(2) *Systematic Account* ;

(3) *Distribution* ;

(4) *Zoogeographical Review*, in which the principal features of the distribution are examined in relation to other oceans and other animal groups, etc.

HYDROLOGICAL ENVIRONMENT

The collections reported here were made principally in the two major water masses of the North Pacific Ocean, the Sub-Arctic water mass in the Sub-Arctic Zone and the North Pacific Central water mass in the Sub-Tropical Zone. Between these there is generally a broad belt of water with intermediate hydrological characteristics in the Transition Zone from which samples have also been examined (Text-fig. 3).

The term Sub-Arctic water should be strictly applied only to the top 1,000 m. of water north of 45° N. (Sverdrup *et al.*, 1946) and it is principally in this sense that the term is used in this paper. No attempt is made here to interpret, in detail, distribution along the western coast of the U.S.A., between 48° N., and 23° N., where a southward flow of modified Sub-Arctic water, the California Current, exists prior to converging with Equatorial water.[1]

The hydrological data obtained on the Trans-Pacific Expedition has been inter-

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[1] Dales (1957) has reported on the distribution of pelagic polychaetes in the California Current (1949–50) within 75 metres of the surface : his data will be referred to here in terms of general oceanic distribution only.

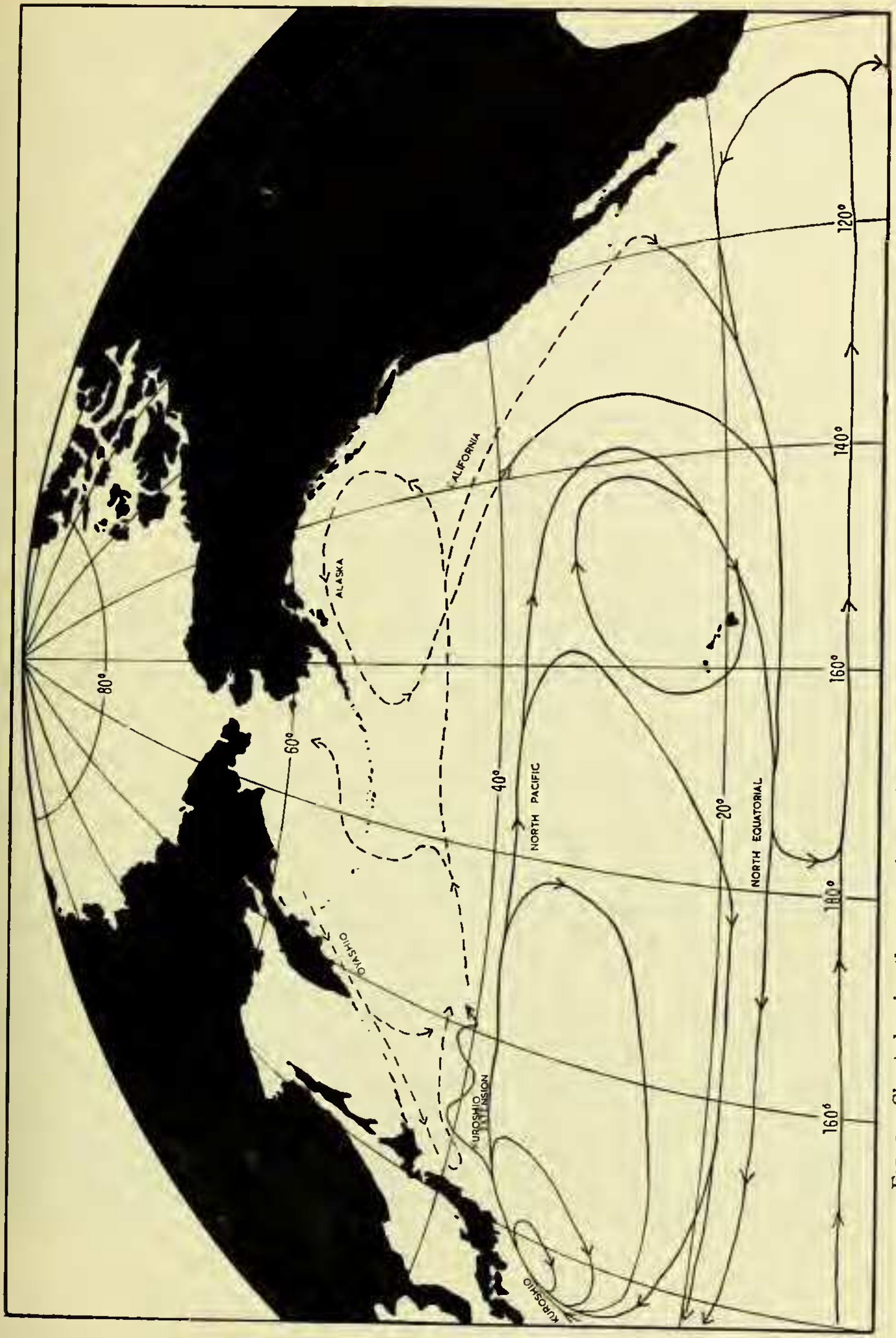

FIG. 2. Chart showing the approximate direction of the transport of water in the North Pacific above 1,500 m. (after Sverdrup *et al.*, 1946, fig. 205).

preted by Warren Wooster and Bruce Taft and the T/S diagram (Text-fig. 3) prepared by them. This diagram differs from that in Sverdrup *et al.* (1946, fig. 209B) in that no differentiation has been made between Eastern and Western North Pacific Central water. In a schematic sense, however, it does indicate clearly the characteristics of the Sub-Arctic water mass, the broad belt of Transition water and the North Pacific Central water as sampled in 1953 by the Trans-Pacific Expedition.

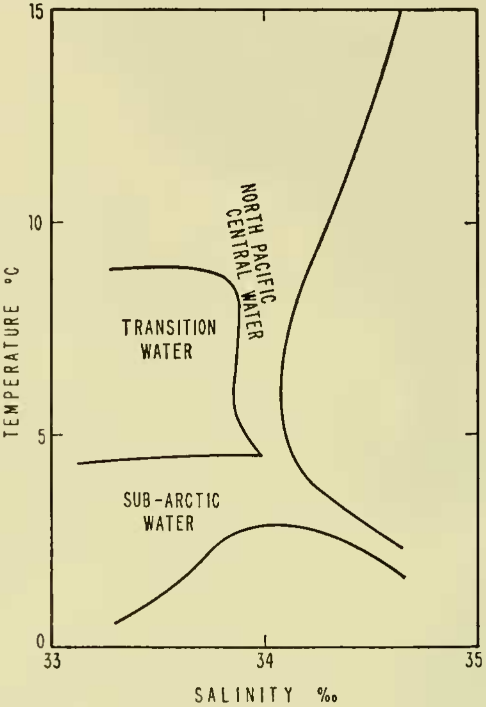

FIG. 3. Temperature/salinity diagram for the North Pacific Ocean from data obtained by the Trans-Pacific Expedition, 1953.

From the T/S diagram Wooster and Taft have interpreted the positions of stations from which samples have been examined; these positions have been plotted on all distribution maps. Normally positions of the stations in relation to the water masses are comparatively clear but, in the region off the north-east coast of Japan, where the warm Kurushio current meets the cold Oyashio (Text-fig. 2), the conditions are more complicated. Thus Stations 71, 72, 73 and 78 were essentially Sub-Arctic in character but had a layer of Transition water at the surface, and Stations 74 and 77 Sub-Arctic below 450 metres but in North Pacific Central water above this depth.

SYSTEMATIC ACCOUNT

This section deals with descriptions of the species collected and with a re-examination of the taxonomic status of some of them. A short note on general distribution is appended to each description, but reference should be made to the section on Distribution (below, pp. 428–469) for a more detailed consideration of this aspect of the work.

Recent systematic analyses of pelagic polychaetes by Støp-Bowitz (1948), Dales (1957) and Tebble (1960) make repetition of lengthy lists of synonyms unnecessary. References to descriptions of species have therefore been restricted to these three works, original descriptions and Fauvel (1923) except where necessary. The spelling of specific names in these lists of synonyms follows that used in each particular reference.

The material collected by the research ships of the University of California has been deposited in the British Museum (Natural History) collections, Reg. No. 1960.6.1. 1–11,186, and the Scripps Institution of Oceanography, La Jolla, California; material collected by the Pacific Oceanic Fisheries Investigations in the Smithsonian Institution, Washington D.C., and by the University of Washington, is in the University Dept. of Oceanography, Seattle.

Family TOMOPTERIDAE

Exclusively pelagic. Prostomium with a pair of laterally directed antennae which together form its anterior border, a pair of nuchal organs and normally a pair of eyes. There may be two pairs of lateral processes just behind the eyes of which the anterior and smaller pair is often not present (the first pair of chaetigers) whereas the posterior pair is always present (the second pair of chaetigers). Parapodia are biramous and achaetous with notopodia and neuropodia modified into paddle-shaped pinnules. These pinnules may carry glands which have been given the following names: (*a*) chromophil glands, these are large glands which normally appear only in neuropodia and stain deeply with haematoxylin; (*b*) hyaline glands, small glands which occur in either notopodia or neuropodia, they may be pigmented or appear only as crystalline spots; they do not stain with haematoxylin; (*c*) rosette glands, very small glands which occur on the trunks of the parapodia or on notopodia and neuropodia, they do not stain with haematoxylin; (*d*) spur glands, these are small, normally subsidiary to the chromophil glands, and occur only on neuropodia, they stain with haematoxylin. Posteriorly the body may be prolonged into a tail, bearing rudimentary parapodia.

Genus ***TOMOPTERIS*** Eschscholtz, 1825

Notopodial and neuropodial pinnules always completely surrounding the parapodial trunk.

Type species. *Tomopteris onisciformis* Eschscholtz, 1825.

Type locality. South Seas (Pacific).

I have given elsewhere (Tebble, 1960) my reasons for not accepting the subgeneric division of *Tomopteris* into *Tomopteris* (*sensu stricto*) and *Johnstonella*.

TABLE II.—*In this Table the Presence* (×) *or Absence* (–) *of the More Important Diagnostic Characters in Some Species of* Tomopteris *is Indicated*

		Hyaline glands					Chromophil glands				
	First chaetigers	Apical	Dorsal	On most feet	On 3rd and 4th feet only	Rosette glands	Compact	Diffuse	With spur	Pinnules extend to body wall	Tai
T. planktonis	–	×	–	×	–	–	×	–	–	–	–
T. septentrionalis	–	–	×	×	–	–	–	×	–	–	–
T. ligulata	–	–	×	×	–	–	×	–	–	×	–
T. elegans	×	–	×	–	×	–	×	–	–	–	–
T. nisseni	–	×	–	×	–	–	×	–	–	–	×
T. krampi	×	×	–	×	–	–	×	–	–	–	×
T. apsteini	×	–	–	–	–	×	×	–	×	–	×
T. pacifica	×	–	–	–	–	×	×	–	–	–	×

* Of the species listed *T. krampi* was not present in the collections but was reported in the North Pacific from Monterey Bay by Dales (1955).

Tomopteris elegans Chun, 1887

(Text-fig. 4*a*, *b*)

Type locality. Canary Islands, 500–1,300 m.

Tomopteris elegans Chun, 1887, pp. 18–19, pl. 3, figs. 4–9.
Tomopteris (*Tomopteris*) *elegans*: Fauvel, 1923, p. 223, fig. 84, *b*, *c*.
Tomopteris (*Tomopteris*) *elegans*: Stop-Bowitz, 1948, pp. 46–48, fig. 33*a*–*b*.
Tomopteris elegans: Uschakov, 1957*a*, pp. 283–284, Chart 3, fig. 7*a*–*c*.
Tomopteris (*Tomopteris*) *elegans*: Dales, 1957, pp. 142–143, figs. 51a, 52a, 53.
Tomopteris elegans: Tebble, 1960, pp. 179–180, fig. 11, *a*–*c*; pp. 250–252, fig. 48.

DESCRIPTION. This species varies between 1·5 mm. in length for ten pairs of parapodia and 6·5 mm. for fifteen pairs, with most specimens having fourteen pairs. The anterior border of the antennae has a pronounced central indentation and there is a pair of pale brown eye spots on the prostomium. (These may not be well preserved.) The first pair of chaetigers is always present; the second pair varies in length but normally reaches to almost the total length of the body (though frequently broken off, as in the specimens shown in Text-fig. 4). Pigmented hyaline glands are present on the notopodial pinnules of the third and fourth parapodia only; they are absent from all other feet. Compact chromophil glands appear from the fourth neuropodial pinnule on all parapodia up to the end of the body; they are ventral in position just below the apex of the parapodial trunk. There is no tail in this species.

DISCUSSION. Dales (1957 : 160) notes that *T. elegans* has, " Gonads present in the 3rd to 8th pairs of parapodia "; by gonads he must mean gonadial products, but I have never found these restricted to particular segments in this species. Text-fig. 4*a* shows them occurring in every foot from the first to the tenth and I have seen them in all and in only one[1].

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[1] Dales uses this character to separate *T. elegans* from *T. kefersteini* Greeff, 1879, which he considers has " gonads present in the 3rd to 9th parapodia ". In fact *T. kefersteini* has itself been described with gonads in all feet (Fauvel, 1923); and although a little-known species it can be distinguished from *T. elegans* by characters noted in its original description (Greeff, 1879).

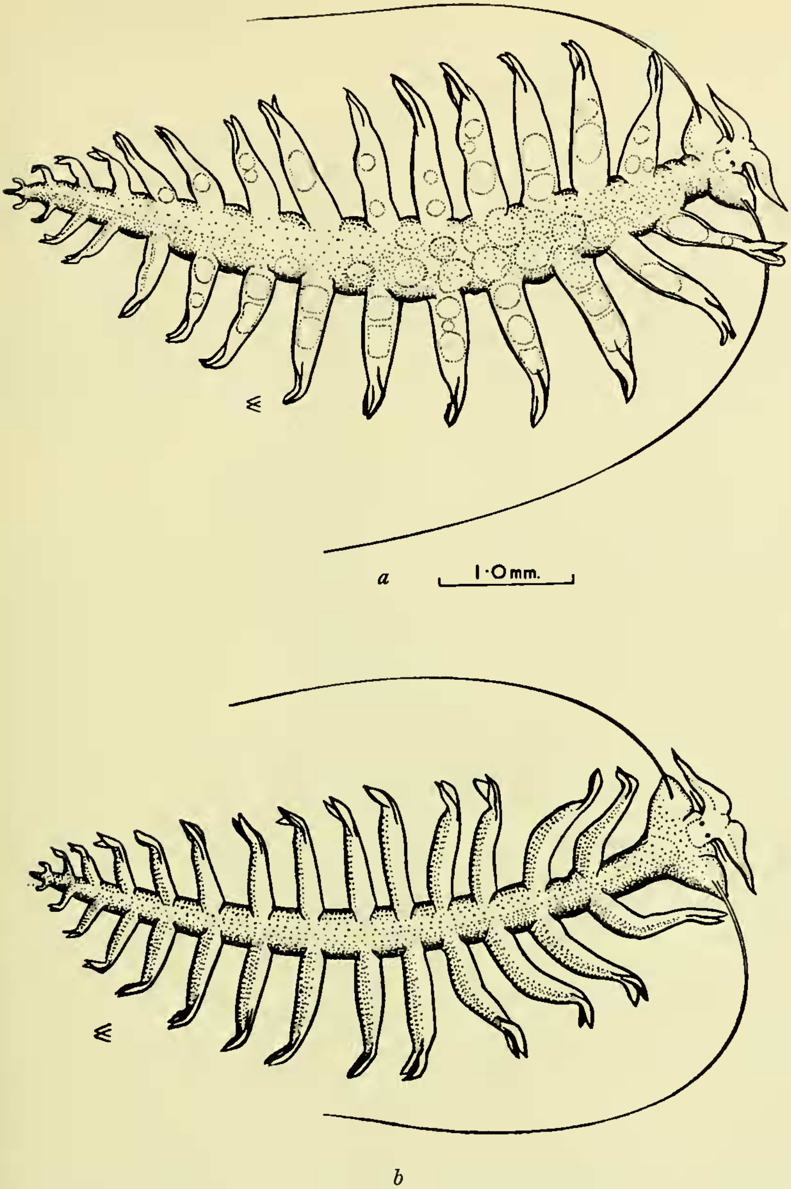

FIG. 4. *Tomopteris elegans* : (*a*) with and (*b*) without eggs in the body cavity. Both specimens are from Stn. 17A of the Trans-Pacific Expedition, and have had the tips of the second pair of chaetigers broken off.

General distribution. *T. elegans* is known only from Tropical and Sub-Tropical waters (see below, pp. 428–434).

Tomopteris septentrionalis Quatrefages, 1865

(Text-fig. 5)

Type locality. " . . . les mers du Danemark ".

Tomopteris septentrionalis Steenstrup, 1849, p. iv (*nomen nudum*).
Tomopteris septentrionalis Quatrefages, 1865, p. 229.
Tomopteris (*Tomopteris*) *septentrionalis:* Støp-Bowitz, 1948, pp. 49–51, figs. 36–37.
Tomopteris septentrionalis: Uschakov, 1957*a*, pp. 282–283, Chart 3.
Tomopteris (*Tomopteris*) *septentrionalis:* Dales, 1957, p. 145, figs. 51*f*, 52*g*, 54.
Tomopteris septentrionalis: Tebble, 1960, pp. 176–177, fig. 8*a*, *b*; pp. 228–231, figs. 32, 33.

Description. The specimens of this species collected vary in length between 1·5 mm. for twelve pairs of parapodia and 20–28 mm. for twenty to twenty-four pairs. The anterior border of the antennae has a prominent central indentation and there is a pair of eye spots on the prostomium. The first pair of chaetigers is never present; the second pair extends almost as far as the body length. The hyaline gland is normally clearly pigmented a red-brown, and appears dorsally on

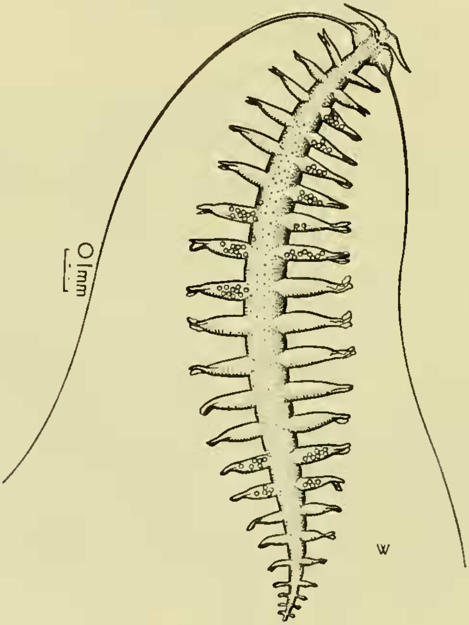

Fig. 5. *Tomopteris septentrionalis:* complete specimen from Stn. 1B of the Trans-Pacific Expedition.

the neuropodial pinnule from the first parapodia, although it may not be distinct on all feet. The chromophil gland appears first on the third pair of parapodia and subsequently on all feet ; it is not a compact gland but consists of a series of ramifying tubules situated between the ventral and apical surfaces. There is no tail in this species.

DISCUSSION. The largest specimens of *T. septentrionalis* from the South Atlantic (Tebble, 1960) are 15 mm. in length, much smaller than the largest reported here from the North Pacific, which are between 20 mm. and 28 mm., a similar size range to that reported by Uschakov (1955) and Berkeley and Berkeley (1957). In general these larger specimens appeared more often in the Sub-Arctic water mass than elsewhere, but more material from warmer waters will have to be examined before the possibility that the Sub-Arctic Zone harbours a distinct population can be sustained.

GENERAL DISTRIBUTION. *T. septentrionalis* has been reported from all explored water masses throughout the world (see below pp. 430–434).

Tomopteris planktonis Apstein, 1900

Original localities. In the Atlantic Ocean between Ascension Island and Brazil, Ascension Island and Cape Verde Islands and between Newfoundland and Iceland.

Tomopteris planktonis Apstein, 1900, p. 42, pl. 11, figs. 21, 22 and pl. 12.
Tomopteris (*Tomopteris*) *planktonis :* Fauvel, 1923, pp. 224–225, fig. 84, *d*.
Tomopteris (*Tomopteris*) *planktonis :* Støp-Bowitz, 1948, pp. 52–54 (in part), fig. 39.
Tomopteris (*Tomopteris*) *cavallii :* Dales, 1957, pp. 144–145, figs. 51*b*, 52*b*.
Tomopteris planktonis : Tebble, 1960, pp. 171–174, fig. 6, *a–f* ; pp. 228–231, fig. 31.

DESCRIPTION. The smallest specimens of this species in the collection measure 2 mm. in length for twelve pairs of parapodia and the largest 9 mm. for eighteen pairs. The anterior border of the antennae is entire and there is a pair of eyes on the prostomium. The first pair of chaetigers is never present. The second pair reaches to about two-thirds the length of the body. Small hyaline glands appear apically on the neuropodial pinnule of all parapodia but they are frequently indistinct. Compact chromophil glands appear on all neuropodial pinnules from the fourth, they are ventral in position and when fully developed extend right into the angle between the pinnule and the ramus. In some specimens there are tubules, like those which make up the chromophil gland, in the dorsal region of the neuropodium and ventral in the notopodium. Bands of brown pigment appear on some specimens either encircling the body or confined to the dorsal or ventral surfaces. There appears to be no particular pattern manifest in the occurrence of these. There is no tail in this species.

DISCUSSION. This material is identical with that reported from the California Current by Dales (1957) as *T. cavallii* ; this species differs from *T. planktonis* in having no hyaline glands but these are present in the material reported here, and by Dales which has been deposited in the British Museum (Natural History).

The appearance of chromophil gland tubules in a dorsal position in neuropodia and ventrally in notopodia in some specimens was noted by Dales (1957, as in *T.*

cavallii) and my observations confirm this. There is no regularity about the appearance of these tubules ; they appear on specimens from widely separated stations, and at one station some specimens may have them and some not. Bands of brown pigment have not, to my knowledge, previously been seen on *T. planktonis* ; these again appear to occur in no regular manner. The extent, and importance, of this variation may become more apparent when comprehensive collections to the south of the area now investigated have been examined.

GENERAL DISTRIBUTION. *T. planktonis* has been widely reported throughout the world from all explored water masses but in the North Pacific it has not been collected in the Sub-Arctic Zone (see below, pp. 434–435).

Tomopteris ligulata Rosa, 1908

Original localities. Atlantic Ocean, 22° N., 35° W., 33° S., 30° W. ; Pacific Ocean, 31° S., 84° W.

Tomopteris ligulata Rosa, 1908*a*, p. 1.
Tomopteris ligulata : Rosa, 1908*b*, pp. 302–304, pl. 12, figs. 18–19.
Tomopteris (*Tomopteris*) *ligulata* : Fauvel, 1923, p. 224, fig. 84*e*.
Tomopteris ligulata : Tebble, 1960, pp. 177–179, figs. 9, 10 ; p. 248, fig. 47.

DESCRIPTION. The smallest specimen of this species in the collection measures 2 mm. in length for twelve pairs of parapodia and the largest 7 mm. for eighteen pairs. The anterior border of the antennae is entire and there is a pair of eyes on the prostomium, these are normally distinct but on occasion may be difficult to see. There is no first pair of chaetigers, the second pair reaches to about two-thirds of the body length. The hyaline gland is distinctly pigmented—normally a red-brown and appears in a dorsal position from the third neuropodial pinnule up to the end of the body. The chromophil gland is compact and appears ventrally from the fourth neuropodial pinnule. The pinnules border the parapodia almost to the junction with the body wall. There is no tail in this species.

GENERAL DISTRIBUTION. This appears to be the first record of *T. ligulata* from the North Pacific Ocean (see below, pp. 437, 438). In the Atlantic Ocean it is known only from Tropical and Sub-Tropical waters.

Tomopteris nisseni Rosa, 1908

Type locality. Atlantic Ocean 20° S., 27° W.

Tomopteris Nisseni Rosa, 1908*a*, p. 1.
Tomopteris (*Tomopteris*) *Nisseni* : Rosa, 1908*b*, pp. 292–294.
Tomopteris (*Tomopteris*) *Nisseni* : Fauvel, 1923, p. 222, fig. 82*e*, *g*.
Tomopteris (*Tomopteris*) *Nisseni* : Støp-Bowitz, 1948, pp. 44–46, figs. 29–30.
Tomopteris nisseni : Tebble, 1960, pp. 180–181, pp. 246–248, fig. 46.

DESCRIPTION. All the specimens collected are in a poor condition of preservation, making examination difficult. In addition they are probably all young forms, the glands are not developed on all feet and the largest measures only 12 mm. in length for fourteen pairs of parapodia. Adult specimens of this species may measure up to 60 mm. in length. The antennae are long and thin and have a prominent central indentation. A first pair of chaetigers is never present ; the second pair is exceedingly long-reaching in young forms to four or five times the length of the body. Parapodial pinnules are reduced to a fringe bordering the rami. Apical hyaline glands appear first on the neuropodial pinnules of the third parapodia and in notopodia from about the eighth. Compact chromophil glands appear on the ventral part of the neuropodial pinnules in all parapodia from the fourth. A tail is present in this species but in most of the specimens examined here it has broken off.

Discussion. There are no eye spots visible in any of these specimens ; this is either because they are juveniles, or because of the poor state of preservation. In well-preserved adult *T. nisseni* I would certainly expect a pair of eye spots to be present.

General distribution. In the Atlantic Ocean *T. nisseni* has been reported from all explored water masses except south of the Sub-Tropical Convergence in the South Atlantic ; in the North Pacific it has not been collected north of the Sub-Tropical Zone (see below pp. 437, 439).

Tomopteris apsteini Rosa, 1908

Type locality. Messina, Mediterranean Sea.

Tomopteris (Tomopteris) Apsteini Rosa, 1908*b*, pp. 288–292, pl. 12, figs. 10–13.
Tomopteris (Johnstonella) Apsteini : Fauvel, 1923, pp. 220–221, fig. 83, *a–d*.
Tomopteris (Johnstonella) Apsteini : Støp-Bowitz, 1948, pp. 39–42, figs. 26–27.
Tomopteris apsteini : Tebble, 1960, p. 183 ; p. 252, fig. 48.

Description. The smallest specimen of this species in the collection measures 8 mm. in length for nineteen pairs of parapodia and the largest 18 mm. also for nineteen pairs. The anterior border of the antennae carries a central indentation. There is a pair of eye spots on the prostomium. The first pair of chaetigers is present extending almost to the length of the antennae ; the second pair reaches to about two-thirds of the length of the body. Rosette glands appear on all parapodia ; on the first two there is one present near the ventral surface within the ramus ; thereafter one is present on all notopodial and neuropodial pinnules near the apex of the parapodial trunk. The characteristic " spur " glands may appear in the first neuropodia projecting prominently from the ventral border of the pinnules. They are always present from the second parapodia and from the third are associated with the large compact chromophil gland. A prominent tail is present normally carrying rudimentary parapodia.

General distribution. *T. apsteini* is known only from Tropical and Sub-Tropical waters (see below, pp. 437, 439).

Tomopteris pacifica Izuka, 1914

(Text-fig. 6)

Type locality. Misaki, Japan.

Tomopteris pacifica Izuka, 1914, pp. 11–12, figs. 1–4.
Tomopteris elegans Berkeley, 1924, pp. 5–6, pl. 1, figs. 1–2 (name preoccupied).
Tomopteris renata Berkeley, 1930, pp. 11–12 (new name to replace *T. elegans* Berkeley, 1924).
Tomopteris renata : Berkeley & Berkeley, 1948, p. 26, figs. 31–32.
Tomopteris (Johnstonella) pacifica : Uschakov, 1955, p. 109.

Tomopteris (*Johnstonella*) *renata*: Uschakov, 1955, p. 110.
Tomopteris (*Johnstonella*) *pacifica*: Dales, 1955, p. 440.
Tomopteris (*Johnstonella*) *renata*: Uschakov, 1957*a*, p. 285, Chart 3.
Tomopteris (*Johnstonella*) *pacifica*: Uschakov, 1957*a*, pp. 285–286, Chart 3.
Tomopteris (*Johnstonella*) *pacifica*: Dales, 1957, p. 141, fig. 51*e*, fig. 52*f*.
Tomopteris (*Johnstonella*) *renata*: Berkeley & Berkeley, 1957, p. 576.
Tomopteris (*Johnstonella*) *renata*: Berkeley & Berkeley, 1960, p. 791.

DESCRIPTION. This species measures between 8 mm. long for fourteen pairs of parapodia and 50 mm. for twenty-four pairs[1]. The antennae are long and thin and carry a central indentation. There is a pair of black eye spots on the prostomium. The first pair of chaetigers is normally present but may be broken off; the stumps, however, are always visible on the ventral surface, just beside the inner edge of the nuchal lobes. The second pair of chaetigers reaches to about two-thirds of the body length. Rosette glands appear on all parapodia; on the first two they are within the parapodial trunk thereafter on the pinnules immediately ventral to the ramus in the notopodium and dorsal in the neuropodium. Chromophil

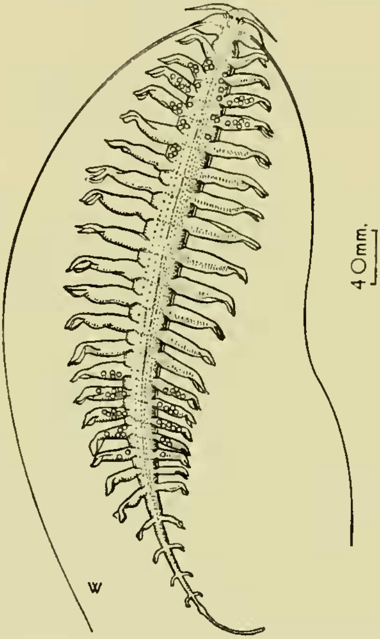

FIG. 6. *Tomopteris pacifica*: specimen from Stn. 46B of the Trans-Pacific Expedition, the first pair of chaetigers has been lost.

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[1] One very poorly preserved specimen from Northern Holiday Expedition Station 23, which could be *T. pacifica* measures 135 mm. in length. This identification, however, cannot be confirmed and has neither been plotted on a chart nor recorded in the appendices of this report.

glands are compact and appear ventrally on the neuropodia of all parapodia from the third backwards. All glands, except the rosettes on the first two parapodia, are always well preserved and clearly visible. A prominent tail with rudimentary parapodia is normally present though it may be broken off.

Discussion. After examining co-type material of *T. renata* Berkeley in the collections of the B.M. (N.H.) (Reg. No. 1938.11.29.6–8) I have no doubt that this species is identical with *T. pacifica*. Berkeley & Berkeley (1957 and 1960) reject the possibility of such synonymy mainly on the grounds that *T. renata* is much the larger, with an abrupt transition from the body to the tail region. I can find no evidence for supporting such a conclusion. The principal difficulty in accepting these two species as identical results from the ease with which the first pair of chaetigers becomes detached from the body. These are almost certainly lost accidentally and not, as suggested by Berkeley (1930), naturally, in the course of the life history of the animal. There are no observations on living tomopterids which substantiate Berkeley's suggestion. Of the specimens examined in this survey over half have lost the first chaetigers and have only the stumps remaining. At some stations some specimens have retained them and others lost them, and at Trans-Pacific Station 50B, the chaetiger is present on one side and missing on the other. In all other characters these specimens are identical with those in which the first chaetigers are present. There is no doubt that identification is difficult when situations of this type arise and confusion between *T. pacifica* and *T. nisseni* and *T. kempi* is possible in this present case.

Text-fig. 6, of *T. pacifica*, has been prepared from a specimen which has lost the first pair of chaetigers.

General distribution. From the evidence obtained in this survey *T. pacifica* appears to be restricted to the Sub-Arctic water mass in the North Pacific Ocean (see below, pp. 434–437). The fact that it was first recorded from Misaki, just outside Tokyo Bay, with a number of other species which are certainly not Sub-Arctic forms, is also discussed below, p. 437.

Family ALCIOPIDAE

Exclusively pelagic. Body normally elongate with numerous segments: exceptionally short and wide with comparatively few segments. Prostomium small with two very large eyes and four, five or six antennae. There are three, four or five pairs of tentacular cirri. Proboscis eversible, with long terminal horns and/or short papillae. Uniramous parapodia, with simple and/or compound chaetae, often with pigmented segmental glands. In mature females some anterior dorsal cirri may be modified into receptacula seminis. Anal cirri present.

Table III below has been prepared to show the principal diagnostic characters of the parapodia which are used in separating genera in the Alciopidae.

Some authors, in particular Dales (1957), have used the angle subtended by the axes of the eyes as a character of value in separating species; in no specimen have I found evidence to support such use. It appears reasonable to assume that a character of this type will vary considerably with the method of fixation of the

TABLE III

Acicular chaetae	Absent	Absent	Simple	Simple	Compound
Capillary chaetae	Simple	Compound	Simple	Compound	Compound
Number of cirriform pedal appendages					
Nil	*Naiades*	*Torrea**	*Alciopina**	*Plotohelmis*	Not known
One	*Watelio**	*Vanadis*	*Krohnia*	*Rhynchonerella*	
Two	*Alciopa**	Not known	Not known	Not known	Not known

* Not reported here.

specimens. Of the Alciopidae reported here only *Naiades cantrainii* and *Rhynchonerella angelini* are normally complete when collected, the remaining species being almost always broken into fragments. In identifying fragments it is generally necessary to have at least the head and anterior parapodia to make a reliable determination. With two species, however, *Vanadis longissima* and *Krohnia lepidota*, the body is characterized by an ornamentation which allows a specific determination to be made with some certainty, even when the head is missing. It will be appreciated, however, that identification of fragments is an unsatisfactory state of affairs, although it is one which workers on polychaetes have to deal with frequently. In the Appendices the presence or absence of alciopid fragments has been noted as an indication of the occurrence of this family even when species were not identifiable. The zoogeographical importance of these results is discussed below, p. 440.

Genus ***NAIADES*** Delle Chiaje, 1830

Body elongate. Prostomium with five antennae. Three pairs of tentacular cirri. Proboscis bell-shaped with two short terminal lobes between which are small papillae. Parapodia with simple chaetae only; the pedal lobe is without an appendage.

Type species. *Naiades cantrainii* Delle Chiaje, 1830.

Type locality. Naples.

Naiades cantrainii Delle Chiaje, 1830

Naiades cantrainii Delle Chiaje, 1830, pl. 82, figs. 14, 18, 21.
Alciopa cantrainii: Izuka, 1914, pp. 2–3, pl. 1, fig. 9.
Alciopa cantrainii: Fauvel, 1923, pp. 203–204, fig. 76.
Alciopa distorta Treadwell, 1943, p. 35, pl. 1, figs. 16, 17; pl. 11, fig. 18.
Naiades cantrainii: Støp-Bowitz, 1948, pp. 24–25, figs. 15–16.
Naiades cantrainii: Dales, 1957, pp. 113–115, figs. 18–20.
Naiades cantrainii: Tebble, 1960, p. 184, p. 257, fig. 51.

DESCRIPTION. Complete specimens of this species may measure up to 110 mm. in length. The body is sharply terminated anteriorly, the eyes projecting forward prominently with the small prostomium between them. There are two pairs of antennae on the anterior edge of the prostomium and an unpaired median antenna on the dorsal surface between the eyes; the latter is in fact a crest with a free anterior edge. There is one pair of tentacular cirri on each of three successive segments behind the head; the most anterior of these is very long, the posterior two minute. The first three pairs of parapodia are reduced, with no chaetae but with aciculae; in mature females the cirri of the second pair are modified as receptacular seminis. The remaining parapodia, up to the end of the body, each have a large foliaceous dorsal cirrus, a slightly smaller ventral cirrus, a prominent projecting acicula, long simple capillary chaetae and a strongly pigmented dorsal segmental gland.

Discussion. I have examined the type specimen of *Alciopa distorta* Treadwell, 1943, in the Smithsonian Institution, No. 20084, and it is identical with *N. cantrainii*.

General distribution. *N. cantrainii* is known only from Tropical and Sub-Tropical waters (see below, pp. 440–441).

Genus ***VANADIS*** Claparède, 1870

Body elongate. Prostomium with two large eyes and with four, five or six antennae. There are three to five pairs of tentacular cirri. Parapodia with long compound chaetae; pedal lobe with terminal appendage. Proboscis with terminal horns and/or papillae.

Type species. *Vanadis formosa* Claparède, 1870.

Type locality. Gulf of Naples.[1]

Key to Species of *Vanadis*

1.	With six antennae (Text-fig. 9)	***V. tagensis***
–.	With four or five antennae	2
2.	With four antennae (Text-fig. 7)	***V. minuta***
–.	With five antennae (Text-fig. 8)	3
3.	Proboscis terminated by twelve equal small papillae	***V. longissima***
–.	Proboscis terminated by two long horns and a varying number of small papillae	4
4.	Parapodia well developed and with chaetae from the third foot posteriorly	***V. formosa***
–.	Parapodia well developed and with chaetae from the seventh to tenth feet posteriorly	***V. crystallina***

Vanadis formosa Claparède, 1870

Vanadis formosa Claparède, 1870, pp. 480–484, pl. 10, fig. 3.
Vanadis formosa: Fauvel, 1923, pp. 305–306, fig. 77, *a–c*.
Vanadis formosa: Treadwell, 1943, p. 36, pl. II, figs. 23–24.
Vanadis formosa: Støp-Bowitz, 1948, pp. 25–26, fig. 17, Chart 18.
Vanadis formosa: Dales, 1957, p. 117, figs. 21–24.
Vanadis formosa: Tebble, 1960, pp. 185–186; pp. 252–255, fig. 49.

Description. No complete specimens of this species were collected; the largest head-fragment measures 73 mm. long for seventy-two chaetigers but most pieces

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[1] Not the Island of Formosa (Taiwan) as in Dales (1957, p. 117, and fig. 63).

are less than 20 mm. in length. Wesenberg-Lung (1939) reports complete specimens up to 300 mm. long from the Mediterranean. All five antennae are small, the dorsal and ventral pairs on the anterior edge of the prostomium and the unpaired in the median line between the large eyes. The proboscis carries two long terminal horns each with a pair of basal ailerons continuous with rows of four to six papillae. There are three pairs of tentacular cirri, one on each of successive segments behind the head ; the first pair is the longest and joined by bulbous basal ceratophores continuous under the ventral surface ; the posterior pairs are equal in length and project out about half the distance of the anterior pair. In mature females the first two pairs of parapodia are reduced, with the dorsal cirri modified as receptacula seminis. In the male these parapodia are reduced but never modified. In both sexes, all parapodia from the third are well developed, with large foliaceous dorsal and smaller ventral cirri, with pedal mamelon and projecting acicula, and with cirriform appendage and compound chaetae with short terminal articles. Darkly pigmented segmental glands appear on each foot after the first three, except in mature females when they may appear in the first two modified parapodia.

GENERAL DISTRIBUTION. *V. formosa* is known only from Tropical and Sub-Tropical waters (see below, pp. 442, 447).

Vanadis crystallina Greeff, 1876

Type locality. Gulf of Naples.

Vanadis crystallina Greeff, 1876, pp. 68–69, pl. 4, figs. 35–39.
Vanadis crystallina : Fauvel, 1923, pp. 206–207, fig. 77, *d*, *e*.
Vanadis crystallina : Støp-Bowitz, 1948, pp. 27–29, figs. 19–20.
Vanadis crystallina : Dales, 1957, pp. 118–119, figs. 25–28.
Vanadis crystallina : Tebble, 1960, pp. 186–187, pp. 252–255.

DESCRIPTION. No complete specimens of this species were collected ; the longest head-fragment is only 9 mm. long for twenty-five pairs of parapodia, but in *Discovery* collections from the South Atlantic (Tebble, 1960) a complete specimen was 143 mm. in length. *V. crystallina* differs from *V. formosa* in having the first seven to ten pairs of parapodia rudimentary, with no chaetae and only very small cirri ; in *V. formosa* fully developed parapodia are present from the third foot.

GENERAL DISTRIBUTION. *V. crystallina* is known only from Tropical and Sub-Tropical waters (see below, pp. 442, 445).

Vanadis minuta Treadwell, 1906

(Text-fig. 7)

Type locality. Off Hawaii.

Vanadis minuta Treadwell, 1906, pp. 1158–1159, figs. 25–278.
nec. *Vanadis fusca-punctata* Treadwell, 1906, pp. 1159–1160, figs. 29–31.
Vanadis minuta : Dales, 1957, pp. 119–121, figs. 28–30.

DESCRIPTION. No complete specimens of this species were collected ; the longest head-fragment is 15 mm. in length. Treadwell's original material does not appear to have been complete, the first twenty-one segments measuring 8 mm. The proboscis has two long terminal processes, each carrying a pair of basal ailerons between which there are no papillae. There are three pairs of small tentacular cirri, one on each of successive segments behind the head ; the first of these pairs is the largest and joined ventrally by basal ceratophores ; the second and third are equal in size. There are only four antennae, all on the anterior border of the prostomium arranged in dorsal and ventral pairs ; of these the ventral pair is sharply pointed and noticeably the longer, being always at least twice as long as the blunt dorsal pair. No median unpaired antenna is present in this species : on the top of the prostomium, between the eyes (where the unpaired antenna is present in all other species of *Vanadis*) there is a pronounced crest but this cannot be called an antenna. The anterior seven pairs of parapodia are achaetous with very small cirri ; thereafter parapodia are fully developed ; chaetae are long and compound, cirri ovate, and the pedal lobe carries a cirriform appendage. In mature females the dorsal cirri of the second parapodia are modified as receptacula seminis. None of the specimens examined has the pigmented segmental glands preserved sufficiently well to allow accurate examination.

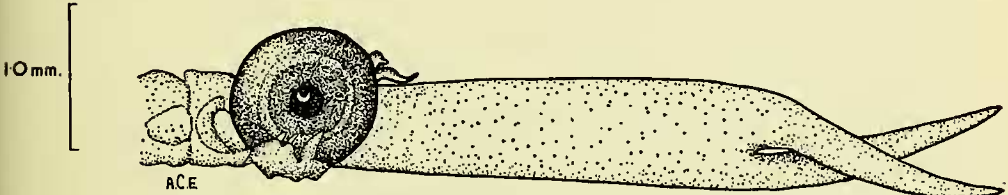

FIG. 7. *Vanadis minuta* : lateral view of head and extruded proboscis of specimen from Stn. 63 of the Northern Holiday Expedition.

DISCUSSION. Dales (1957) was the first to record *V. minuta* after its original discovery ; I have examined some of his specimens in the B.M. (N.H.) collections, and they are identical in all respects with those described here including having four antennae. In suggesting however, that *V. fusca-punctata* is synonymous with *V. minuta*, both he and Treadwell (1943) allow for the possibility that the latter species has a fifth unpaired median antenna as Treadwell's (1906) drawing of the type of *V. fusca-punctata* clearly shows this organ present, and his description mentions it. There is no precedent for suggesting any species of Alciopidae has a variable number of antennae ; no work on the life history of any species of the family suggests this as likely. Indeed it is a basic tenet of the systematic analysis of adult polychaetes, that the number of antennae within a species is constant.

GENERAL DISTRIBUTION. *V. minuta* is known only from the Pacific Ocean where it has been collected in Tropical and Sub-Tropical waters (see below, pp. 440–443).

Vanadis longissima (Levinsen), 1885

(Text-fig. 8)

Type locality. 26° 0′ N., 26° 0′ W.

Rhynchonerella longissima Levinsen, 1885, pp. 330–331, figs. 7–10.
Vanadis grandis Izuka, 1914, pp. 5–7, pl. 1, figs. 1–7.
Vanadis longissima: Fauvel, 1923, p. 207, figs. 77*f–g*.
Vanadis pacifica Uschakov, 1957*a*, pp. 275–277, Chart 2, fig. 4*a–d*.
Vanadis longissima: Dales, 1957, pp. 121–123, figs. 31–33.
Vanadis longissima: Tebble, 1960, pp. 187–188; p. 224, fig. 27.

Description. No complete specimens of this species were collected; the longest head-fragment measures 160 mm. in length. There are four anterior antennae, in dorsal and ventral pairs on the front edge of the prostomium and a median unpaired antenna between the large eyes; irregular black spots may be present on the eyes in some specimens. The proboscis carries twelve small terminal papillae. There are three pairs of tentacular cirri, one on each of successive segments behind the head; all are approximately equal in length, the foremost pair being joined ventrally by basal ceratophores. The first pair of parapodia is achaetous with small foliaceous dorsal cirri and minute ventral cirri. In mature females the dorsal cirri of the second and third parapodia are converted into darkly pigmented receptacula seminis. From the fourth chaetiger parapodia gradually increase in size to a constant width from about the tenth; pedal lobes project about twice as far as the dorsal cirri and carry a prominent cirriform appendage; dorsal cirri are foliaceous and ventral cirri conical; chaetae are long and compound. On specimens other than mature females the second and third parapodia are achaetous with small cirri. Pigmented segmental glands appear at irregular intervals along the body, variously grouped over two to eight segments, with the pigment often extending over the ventral and dorsal surface, giving a striped appearance to the specimens. The first group of pigmented glands may appear on any of the first ten parapodia.

Discussion. In reporting on the *Discovery* collections (Tebble, 1960) from the South Atlantic I noted that *V. longissima* and *V. antarctica* could be separated with certainty only from complete specimens. Because no complete specimens have been found in the present survey it follows that, theoretically, none of the determinations of *V. longissima* made here can be absolutely certain. In the Atlantic, and Pacific Oceans however, *V. antarctica* has never been reported north of the Antarctic Convergence and it is reasonable to assume that in the North Pacific Sub-Tropical Zone the material examined is *V. longissima*.

I do not think that *V. pacifica* Uschakov (1957*a*) is a valid species. Uschakov separates it from *V. grandis* (= *V. longissima*) on a combination of the different number of tentacular cirri and poorly developed anterior parapodia. Because tentacular cirri are frequently lost, and chaetae may be missing, either accidentally, or through normal development, on anterior feet, it is easy to mistake parapodial cirri for tentacular cirri. This Izuka (1914) did in his original account of *V. grandis*, and has led Uschakov to establish *V. pacifica* as a separate species.

Specimens of *V. longissima* from five localities, Trans-Pacific Exp., Stns. 51A, 54A, and 56A, and *Hugh M. Smith* Cruise 30, Stns. 74 and 96 have irregular black spots on the eyes and surrounding areas. Stn. 51A is from the Transition Zone, and the other four stations are from close to the boundary separating it from the Sub-Tropical Zone[1] and although these records are few the presence of specimens with this unusual character (the first time it has been recorded) in and near the Transition Zone should be noted as possibly indicative of a distinct population inhabiting this region. It is shown below, p. 442, that the northern boundary of the Transition Zone is the northerly limit of the distribution of *V. longissima* in the North Pacific and it is of interest that at its southern limit in the South Atlantic at the Antarctic Convergence it meets the endemic antarctic form *Vanadis antarctica*, which it was suggested in Tebble (1960), may be a geographical race rather than a separate species. This suggestion may now be taken a little further. It is possible that, at the extremities of its range in higher latitudes, *V. longissima* has developed, or is developing, separate populations capable of establishing themselves in dis-

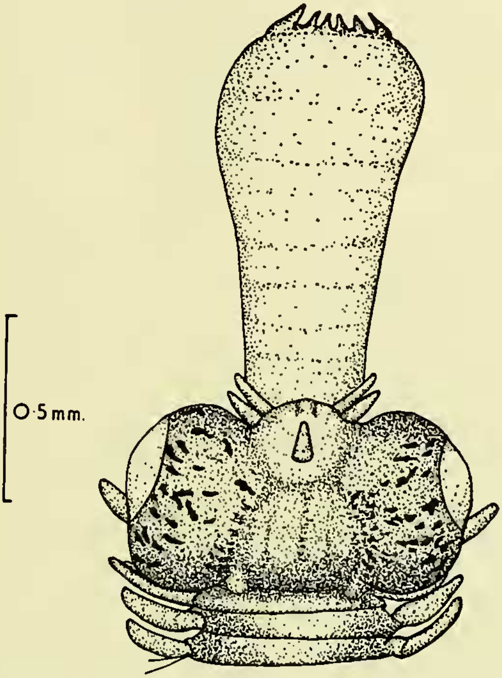

FIG. 8. *Vanadis longissima* : dorsal view of head and extruded proboscis, showing marking on the eyes ; specimen from Stn. 74, of *Hugh M. Smith* Cruise 30.

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[1] Specimens of *V. longissima* from Trans-Pacific Stns. 70E, 76A and *H. M. Smith* Cruise 30, Stn. 29 also near this boundary, are without heads.

tinctive hydrological environments. In the case of *V. longissima–V. antarctica* about the Antarctic Convergence, semi-sympatric speciation, involving ecological allopatry and genetical continguity (Cain, 1954) may have taken place, whereas near the Transition Zone in the North Pacific *V. longissima* may be developing a physiological race.

GENERAL DISTRIBUTION. In the North Pacific and North Atlantic *V. longissima* has never been found in Arctic or Sub-Arctic waters (see below, p. 442) ; in the South Atlantic, however, it penetrates the Sub-Antarctic Zone as far as the Antarctic Convergence, and in the Antarctic Zone it may be represented by *V. antarctica.*

Vanadis tagensis Dales, 1955 (characters emended)

(Text-fig. 9)

Type locality. Monterey Bay, California, in a depth of 1,000 to 500 metres.

Vanadis tagensis Dales, 1955, pp. 436–439, figs. *1a, b, c.*

DESCRIPTION. No complete specimens of this species were collected ; the longest head fragment is 51 mm. in length for sixty pairs of parapodia. There are six antennae in this species not five as noted in the original description. Text-fig. 9 has been prepared from a paratype in the B.M. (N.H.) collections, Reg. No. 1955.9.30.4 and shows, apart from the anterior dorsal and ventral pairs, and the fifth unpaired on the top of the prostomium, a sixth antenna in the anterior region of the prostomium above and between the ventral pair. This sixth antenna is small and, after preservation in formalin, may be difficult to see. There are twelve terminal papillae on the proboscis of which two lateral pairs are the longest, being about twice as long as the dorsal and ventral groups of four. There are four pairs of tentacular cirri on three successive segments behind the head arranged thus 1 + 1 + 1/1. The most anterior of these is almost joined ventrally by basal ceratophores. The anterior seven parapodia are much reduced with small cirri and aciculae ; they may have a few chaetae present. Thereafter cirri are well developed and ovate, the dorsal twice as long as the ventral and the pedal lobe prominent. In mature females the dorsal cirri of the first two parapodia are modified as receptacula seminis. Chaetae are long and compound. None of the specimens available is sufficiently well preserved to permit a critical diagnosis of the arrangement of the pigmented segmental glands.

DISCUSSION. This species presents two characteristics met nowhere else in the genus, six antennae and four pairs of tentacular cirri, and should be considered quite distinct from known species. It may be that its distinctive habitat (it is the only *Vanadis* known to inhabit deep water exclusively, see below p. 442) provides a key to this disposition of normally stable features.

GENERAL DISTRIBUTION. *V. tagensis* is at present known only from deep water in the North Pacific Ocean, south of the Sub-Arctic Zone (see below, pp. 442, 446–447).

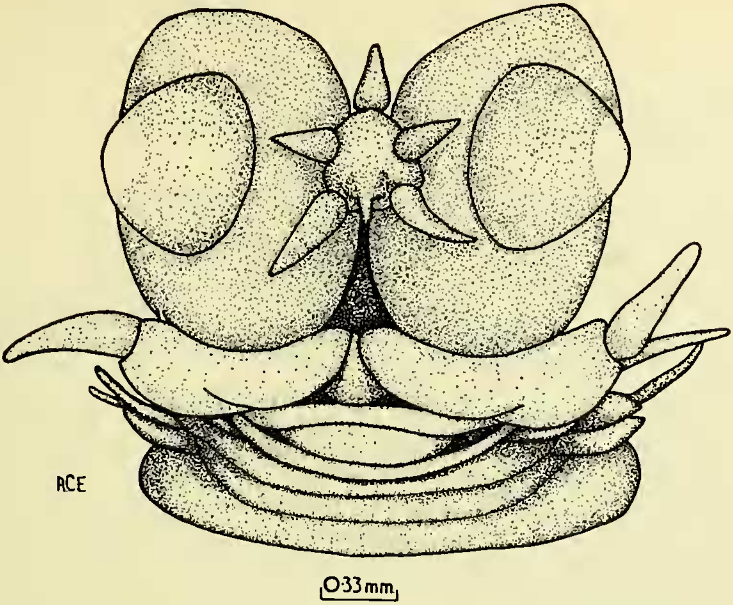

FIG. 9. *Vanadis tagensis* : ventral view of head showing six antennae : Paratype, B.M. (N.H.), Reg. No. 1955.9.30.4.

Genus *RHYNCHONERELLA* Costa, 1862

(Emended Claparède, 1868 pro *Rhynchonereella* Costa, 1862)

Body normally elongate. Prostomium extending beyond the eyes and carrying five antennae. Five pairs of tentacular cirri. Parapodia with a cirriform appendage on the pedal lobe ; acicular chaetae simple or compound ; long slender chaetae (capillaries) always compound.

Type species. *Rhynchonerella gracilis* Costa, 1862.
Type locality. Gulf of Naples.

KEY TO SPECIES

1. With simple acicular chaetae 2
–. With compound acicular chaetae 3
2. Simple acicular chaetae present on the first six to ten chaetigers, but compound capillaries absent (Text-fig. 11) ; both types of chaetae on remaining feet. Acicular chaetae with a few distal spines (Text-fig. 11) . . . . . . **R. mobii**
–. Simple acicular chaetae and compound capillary chaetae present from the first parapodia (Text-fig. 10*a*). Acicular chaetae smooth . . . . . . **R. gracilis**
3. Compound acicular chaetae with a large, serrated terminal article (Text-fig. 12*a–c*) **R. petersii**
–. Compound acicular chaetae with a small, sooth terminal article (Text-fig. 14*c*) **R. angelini**

Rhynchonerella gracilis Costa, 1862

(Text-fig. 10*a*, *b*)

Rhynchonereella gracilis Costa, 1862, p. 168, pl. 4, figs. 13–15.
Callizona nasuta Greeff, 1876, p. 72, pl. VI, figs. 60–62.
Callizona japonica Izuka, 1914, pp. 7–8, pl. 1, fig. 8.
Callizona nasuta : Fauvel, 1923, pp. 215–216, fig. 81*a–c*.
Rhynchonerella gracilis : Stop-Bowitz, 1948, p. 36.
Callizona nasuta : Uschakov, 1957*a*, pp. 279–281, Chart 2, fig. 6*a–d*.

DESCRIPTION. Most specimens collected were anterior pieces rarely measuring more than 8 mm. in length but one complete specimen, from Stn. 112A of the Trans-Pacific Expedition is 20·5 mm. long for 116 chaetigers. The specimen reported by Izuka, (1914 as *C. japonica*) from Misaki measured 36 mm. for about 190 segments. The proboscis is covered with small papillae, all of the same size ; there are no terminal papillae. The prostomium protrudes prominently in front of the eyes and carries two pairs of anterior foliaceous antennae with a smaller unpaired antenna between the eyes. Two parallel lines of light brown pigment run down the middle of the protruding prostomium (these may not always be well preserved). The five pairs of tentacular cirri are arranged on three successive segments behind the head thus 1 + 1/1 + 1/1 ; of these the dorsal are the longest and the posterior the longer. Pigmented segmental glands are present on every chaetiger from the first (these are only rarely not visible). One or two simple acicular chaetae appear on anterior feet with a bundle of long compound capillaries. On posterior feet there is only one acicular chaeta. There is a very prominent cirriform pedal lobe on all feet. The body is terminated by an unpaired anal cirrus.

GENERAL DISTRIBUTION. *R. gracilis* is known only from Tropical and Sub-Tropical waters (see below, pp. 446, 450–451).

Rhynchonerella mobii (Apstein), 1893

(Text-fig. 11)

Type locality. Mediterranean Sea.

Callizona Mobii Apstein, 1893, p. 147.
Callizona Moebii : Fauvel, 1923, pp. 213–214, fig. 80*a–d*.
Rhynchonerella Mobii : Stop-Bowitz, 1948, p. 34.
Rhynchonerella mobii : Dales, 1957, pp. 131–132, figs. 39, 40–43.

DESCRIPTION. The majority of specimens collected are incomplete anterior fragments, less than 15 mm. in length, but from Northern Holiday Expedition Stn. 54 there is an almost complete specimen measuring 45 mm. in length for approximately 170 chaetigers. The prostomium protrudes in front of the eyes and

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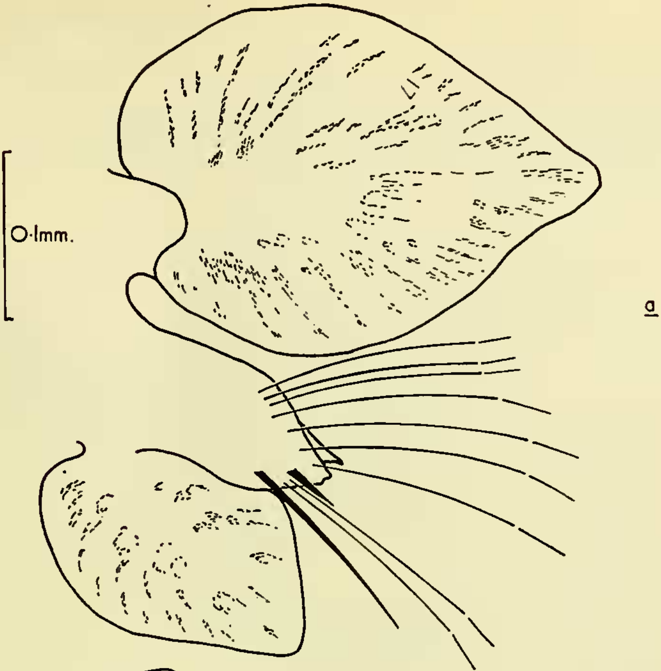
FIG. 10. *Rhynchonerella gracilis :* parapodia, (*a*) from second chaetiger of specimen from Stn. 107A or the Trans-Pacific Exp., (*b*) from ninetieth chaetiger of specimen from Stn. 117A.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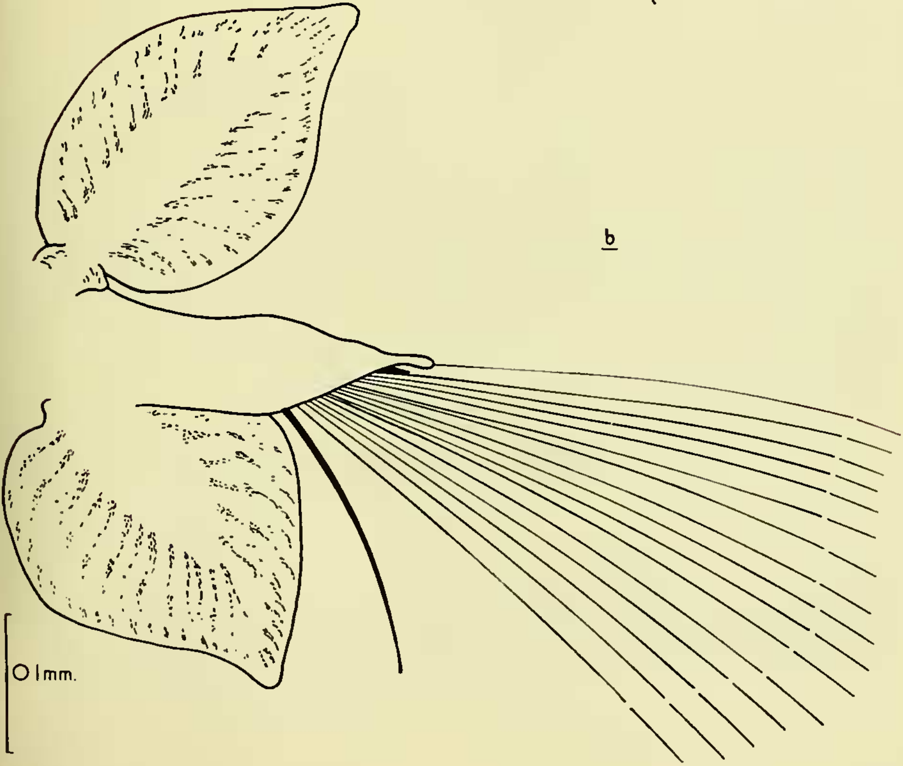
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carries two pairs of stout anterior antennae and a single small, unpaired, antenna between the large eyes. The five pairs of tentacular cirri are arranged on three successive segments behind the head thus $1 + 1/1 + 1/1$: of these the anterior is short and fat; the two dorsal are strap-like, equal in length and the longest of all; the anterior ventral very short and fat; the posterior ventral broadly foliaceous.

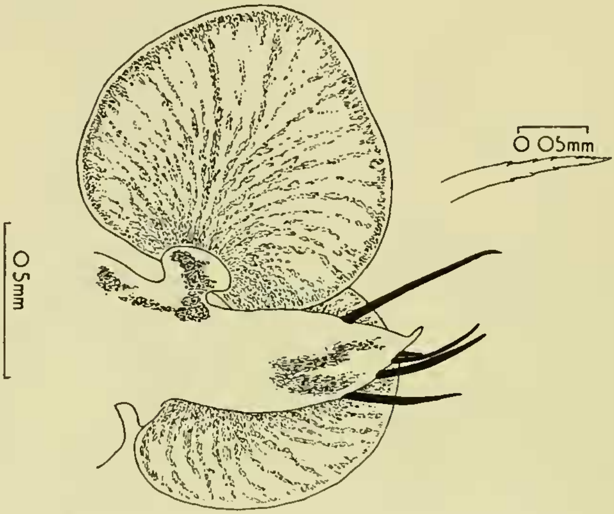

Fig. 11. *Rhynchonerella mobii*: parapodium from the fifth chaetiger of specimen from Stn. 86B of the Trans-Pacific Exp., with acicular chaeta enlarged.

Pigmented segmental glands appear on every foot from the seventh on the few specimens in which they are visible. Anterior parapodia have three to six simple acicular chaetae only; from the tenth to the twelfth foot compound capillary chaetae appear and acicular chaetae are gradually reduced until there is only one in each foot. The distal ends of the acicular chaetae are slightly serrated; this serration is visible only at high magnifications. Dorsal and ventral cirri are broadly foliaceous, the former being the larger. There is a very prominent pedal lobe on all parapodia.

General distribution. *R. mobii* is known only from Tropical and Sub-Tropical waters (see below, pp. 446–449).

Rhynchonerella petersii (Langerhans), 1880*

(Text-fig. 12*a*, *b*, *c*)

Type locality. Madeira.

Alciopa (*Halodora*) *Petersii* Langerhans, 1880, p. 312, pl. XVII, fig. 49.
Callizona setosa: Fauvel, 1923, p. 214, fig. 80*c*, *f*.
Rhynchonerella petersii: Støp-Bowitz, 1948, p. 34.
Callizona setosa: Uschakov, 1957*a*, p. 281, chart 2, fig. 6*e*–*i*.

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* See Addenda, p. 492.

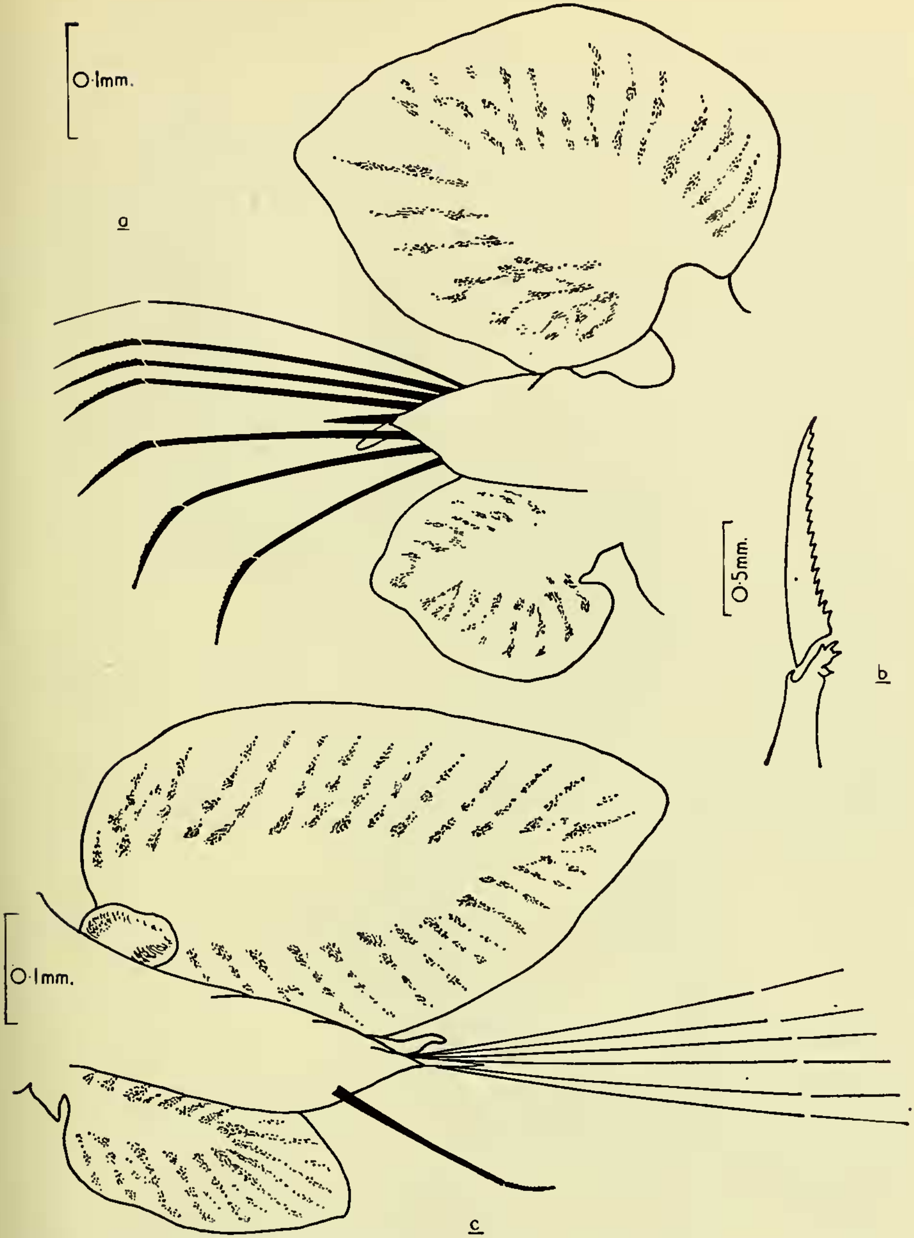

FIG. 12. *Rhynchonerella petersii* : (*a*) parapodium, from the fourth chaetiger of specimen from Stn. 11A of the Trans-Pacific Exp., (*b*) compound acicular chaeta from anterior chaetiger of specimen from Stn. 129B, (*c*) parapodium from the fourteenth chaetiger of specimen from Stn. 12E.

DESCRIPTION. Only fragments of this species were collected, the largest measuring 10 mm. in length for forty-two chaetigers. The prostomium projects only a little way in front of the eyes and carries four bulbous terminal antennae and one very small median antenna between the eyes. The prostomium, antennae and interior edge of the eyes may be sprinkled with light brown spots. The five pairs of tentacular cirri are arranged on three successive segments between the head thus 1 + 1/1 + 1/1; the anterior one is long and strap-like; the two dorsals are the longest and the posterior one the longer, both pointed; the anterior ventral is very short and digitiform; the posterior ventral small and foliaceous. The proboscis carries twelve small terminal papillae. On anterior parapodia dorsal cirri are large and broadly foliaceous, ventral cirri smaller but of similar shape. On the first four to six parapodia acicular chaetae are much more numerous than compound capillary chaetae; on a specimen from Trans-Pacific Expedition Stn. 3A, for example, there are twelve compound acicular chaetae and one compound capillary chaeta on the first parapodia—see also Text-fig. 12*a* for a specimen from Stn. 11A, which has these chaetae in the proportion of 6 : 1 respectively. From the fourth to sixth feet posteriorly there is a reduction in the number of compound acicular chaetae and an increase in the compound capillaries. The terminal article of all the compound acicular chaetae is denticulated and at high magnification the distal end of the main stem is seen to bear spines. All parapodia carry a prominent cirriform pedal appendage. Pigmented segmental glands may appear on every chaetiger from the third but they are frequently not distinctly preserved.

DISCUSSION. This is the first time that spines have been reported on the distal end of the main stem of acicular chaetae in *R. petersii*. I have checked a specimen of the same species deposited in the B.M. (N.H.) Fauvel Collection (Reg. No. 1928.4.26.746 from the Balearic Islands, Fauvel, 1916 as *Callizona setosa*) and find it identical with the above in this and all other respects.

GENERAL DISTRIBUTION. *R. petersii* is known only from Tropical and Sub-Tropical waters (see below, pp. 446, 448).

Rhynchonerella angelini (Kinberg), 1866

(Text-figs. 13, 14, *a*, *b*, *c*)

Type locality. China Sea, 20° S., 107° E.

Krohnia Angelini Kinberg, 1866, p. 242.
Callizona Angeliin: Fauvel, 1923, p. 215, fig. 81*d–i*.
Callizona angelini: Berkeley & Berkeley, 1948, pp. 40–41, fig. 56.
Rhynchonerella Angelini: Stop-Bowitz, 1948, pp. 34–36.
Rhynchonerella angelini: Dales, 1957, p. 113, figs. 44–46.
Rhynchonerella angelini: Tebble, 1960, p. 192; p. 255, fig. 50.

DESCRIPTION. This is the only species of *Rhynchonerella* which is normally complete when collected; it is comparatively large and robust, the longest specimens

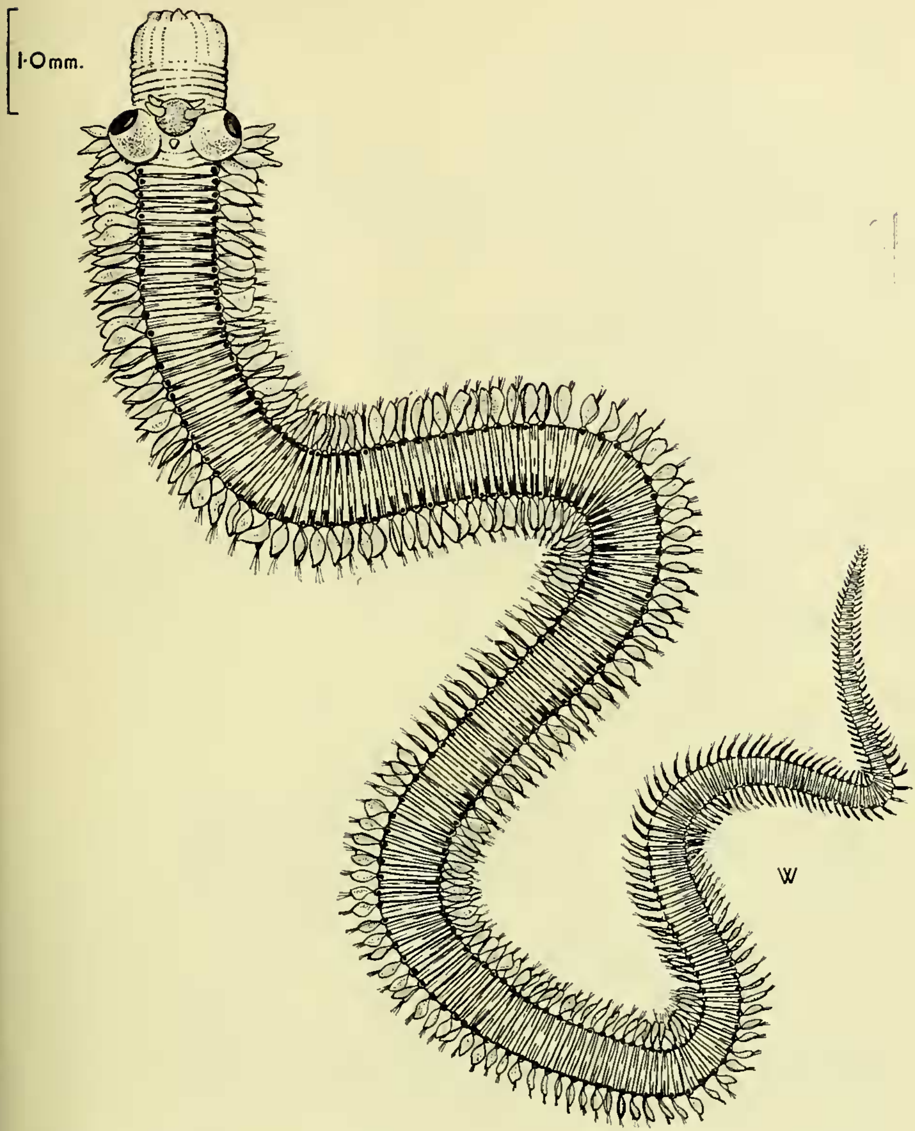

FIG. 13. *Rhynchonerella angelini :* specimen from Stn. 117B of the Trans-Pacific Exp.

measuring 70 mm. in length and the smallest 10 mm. The prostomium protrudes in front of the eyes and carries two pairs of anterior short, dumpy antennae, and a small unpaired antenna immediately behind this prostomial extension, between the large eyes. The prostomium, tentacular cirri, antennae and anterior parapodia are normally covered with a brown pigment. The proboscis is covered with papillae between which there are longitudinal grooves on the anterior half and lateral grooves on the posterior half. The five pairs of tentacular cirri are arranged on three suc-

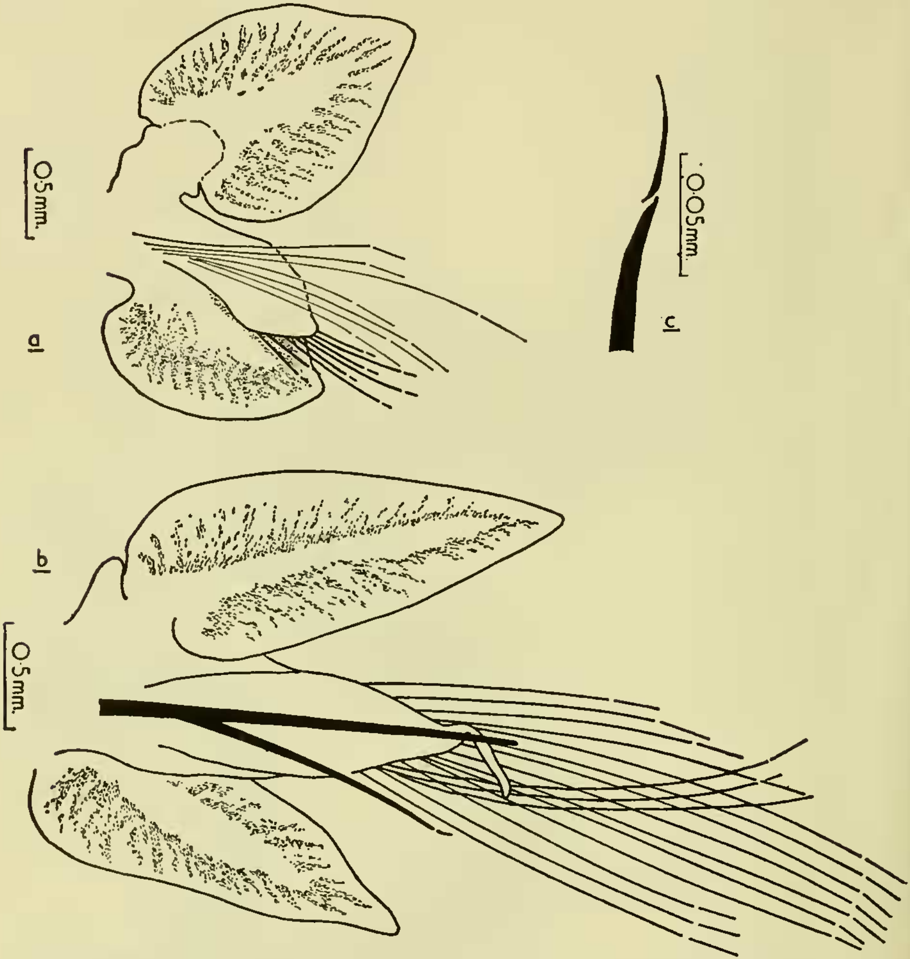

FIG. 14. *Rhynchonerella angelini* : (*a*) parapodium from the fourth chaetiger of specimen from Stn. 50B of the Trans-Pacific Exp., (*b*) the same from the eighteenth chaetiger, (*c*) compound acicular chaeta of specimen from Stn. 117B.

cessive segments between the head thus 1 + 1/1 + 1/1 of these the anterior is short and pointed and the two dorsal long and pointed, the two ventral are short and tend to be foliaceous; all are thick at the base. Over the anterior three-quarters of the body parapodia have broadly foliaceous dorsal cirri which become elongate posteriorly and smaller but still large foliaceous ventral cirri. The first six to ten parapodia have two types of chaetae, an inferior group of stout acicular bristles with short terminal articles and a superior group of compound capillary chaetae with long terminal articles. The acicular chaetae decrease rapidly in number after these first parapodia and are absent over the greater part of the body. On all parapodia there is a prominent cirriform pedal appendage. Posteriorly the body width is considerably reduced assuming the appearance of a whip-cord-like tail.

GENERAL DISTRIBUTION. *R. angelini* is confined to Tropical and Sub-Tropical waters in the southern hemisphere but in the northern extends into higher latitudes (see below, pp. 450, 452).

Genus ***PLOTOHELMIS*** Chamberlin, 1919

Body elongate. Prostomium extending beyond the eyes and carrying five antennae. Five pairs of tentacular cirri. Parapodia without a cirriform appendage on the pedal lobe; acicular chaetae simple, capillary chaetae compound.

Type species. *Plotohelmis alata* Chamberlin, 1919.

Type locality. South Pacific Ocean.

Plotohelmis tenuis (Apstein), 1900

(Text-figs. 15*a*, *b*; 16, 17)

Original localities. Tropical Atlantic Ocean.

Corynocephalus tenuis Apstein, 1900, p. 14, pl. 2, figs. 14–16.
Corynocephalus tenuis: Chamberlin, 1919, p. 141.
Plotohelmis tenuis: Dales, 1957, pp. 125–128, figs. 36–39.

DESCRIPTION. No complete specimens of this species were collected; the longest fragment measures 25 mm. in length. The prostomium projects forward between the eyes as a bulbous outgrowth divided into hemispheres by a median groove; there are four terminal antennae on this outgrowth, two dorsal and two ventral, all are small; the dorsal pair are fat and the ventral thin. There is a pit at the anterior end of the prostomium in which the antennae have their bases. (This pit, which may be filled with extraneous material, should not be confused with the opening of the proboscis which may, or may not, be extruded.) A fifth unpaired antenna is situated on top of the prostomium between the large eyes. When fully extruded the proboscis carries numerous small papillae terminally. There are five pairs of tentacular cirri arranged on successive segments behind the head thus 1 + 1/1 + 1/1.

Of these the posterior ventrals are very small and foliaceous, the posterior dorsals very long and thin, and the anterior lanceolate, of medium length. Parapodia have no cirriform appendage on the pedal lobe, dorsal cirri are large, broadly foliaceous, and ventral cirri cirriform, smaller than the pedal lobe; chaetae are simple aciculars and compound capillaries with long thin terminal articles. Pigmented segmental glands, when preserved, appear at about the ninth foot, becoming larger posteriorly so that they extend along the body wall as a lateral band. Anterior parapodia may have up to a dozen stout acicular chaetae, and no compound

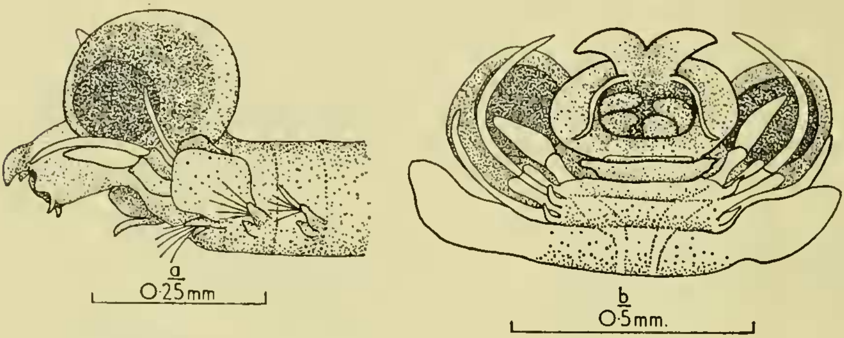

FIG. 15. *Plotohelmis tenuis*: (*a*) lateral view of head and anterior segments of specimen from Stn. 1A of the Trans-Pacific Exp., (*b*) the same, ventral view.

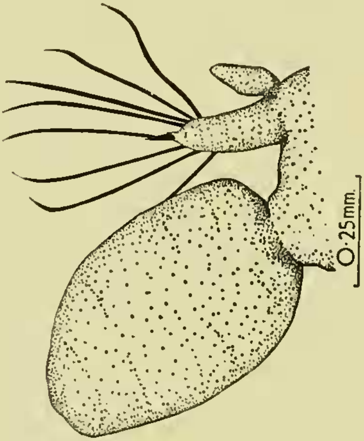

FIG. 16. *Plotohelmis tenuis*: parapodium of the fourth chaetiger of specimen from Stn. 1A of the Trans-Pacific Exp.

capillaries, but from about the sixth foot the latter begin to replace the former till there may be only one acicular chaetae present, always in the most ventral position.

DISCUSSION. Dales (1957) was the first to establish that this species is *Plotohelmis* but I have found no specimens which support his separating the three species within the genus *P. tenuis*, *P. alata* and *P. capitata*, on relative lengths of tentacular cirri.

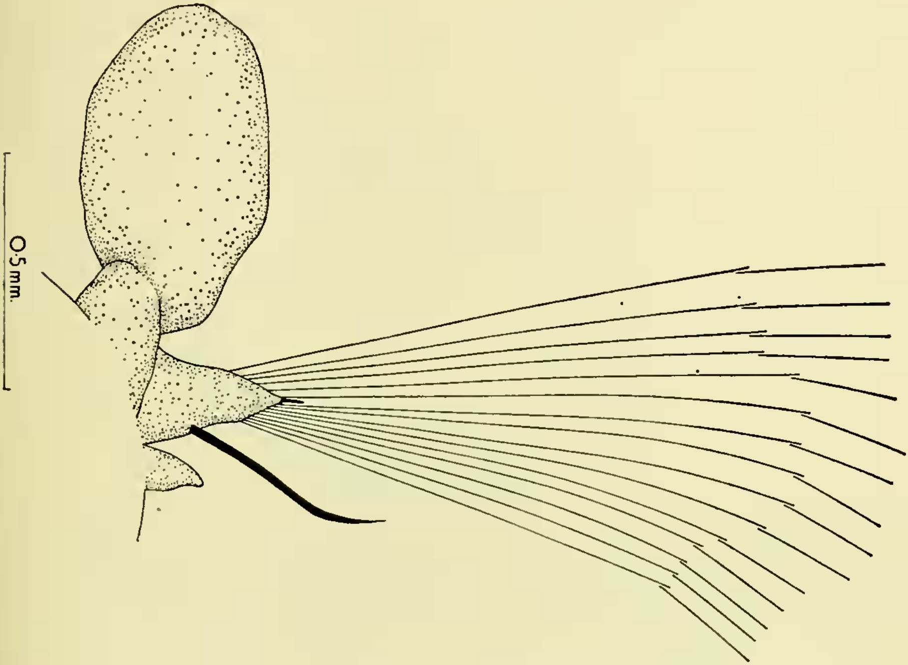

FIG. 17. *Plotohelmis tenuis :* parapodium of the thirtieth chaetiger of specimen from Stn. 1A of the Trans-Pacific Exp.

GENERAL DISTRIBUTION. *P. tenuis* occurs mainly in Tropical and Sub-Tropical waters but may occasionally be found in higher latitudes (see below, pp. 450, 453–4).

Genus ***KROHNIA*** Quatrefages, 1865

Body elongate. Five pairs of tentacular cirri. Parapodia with a cirriform appendage on the pedal lobe, with simple capillary and acicular chaetae only.

Type species. *Alciopa lepidota* Krohn, 1845.

Type locality. Messina, Mediterranean Sea.

Krohnia lepidota (Krohn), 1845

(Text-fig. 18)

Alciopa lepidota Krohn, 1845, p. 175.
Krohnia lepidota: Quatrefages, 1865, pp. 158–159.
Rhynchonerella cincinnata Chamberlin, 1919, pp. 146–147.
Callizona lepidota: Fauvel, 1923, pp. 211–212, fig. 79*e–h*.
Krohnia lepidota: Støp-Bowitz, 1948, p. 33.
Callizonella lepidota: Uschakov, 1957*a*, p. 278, Chart 2, fig. 5.
Krohnia lepidota: Dales, 1957, p. 129.
Krohnia lepidota: Tebble, 1960, p. 193; p. 255, fig. 50.

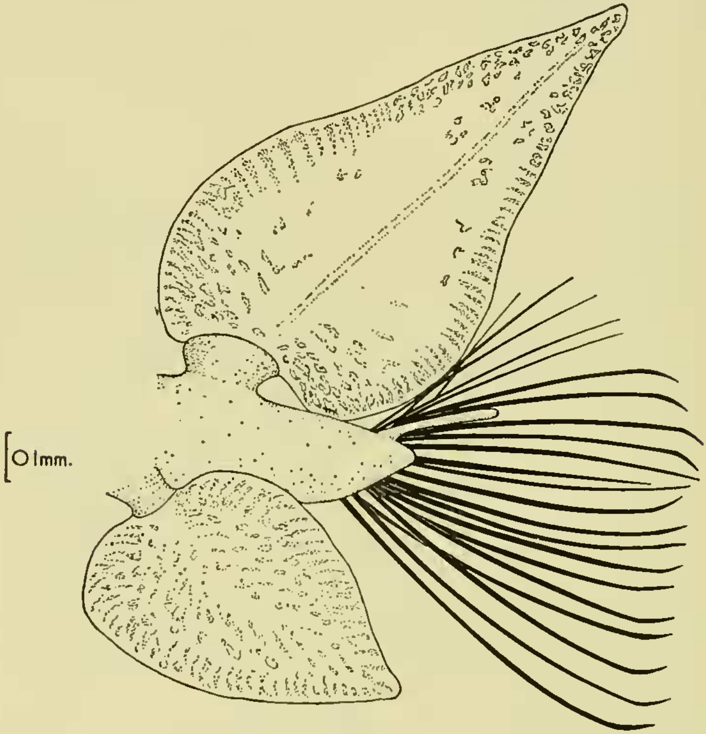

FIG. 18. *Krohnia lepidota:* parapodium of the second chaetiger of specimen from Stn. 120A of the Trans-Pacific Exp.

DESCRIPTION. No complete specimens of this species were collected. The largest fragments rarely measure more than 15 mm. long; Fauvel (1923) gives a maximum of 100 mm. for the length of a complete specimen. Two pairs of small but stout conical antennae are situated on the anterior border of the prostomium and an unpaired antenna occurs dorsally between the eyes. The proboscis is smooth, except for a broad group of small terminal papillae. The five pairs of tentacular cirri appear on successive segments behind the head thus $1 + 1/1 + 1/1$; of these the anterior is long, strap-like and pointed; the two ventrals foliaceous and a little smaller; the anterior dorsal long and thin and the posterior dorsal exceedingly long, reaching out as far again as the total body width. Few of the parapodial cirri have been retained but on one anterior foot the dorsal cirrus is very large and foliaceous and the ventral smaller, and broadly foliaceous. Chaetae are of two types, simple stout acicular chaetae and simple capillaries, the former are more numerous anteriorly and are gradually replaced by the latter posteriorly. The whole body surface is sprinkled with black spots, which run in lines along the antennae and tentacular cirri and are scattered over the eyes and prostomium; they are arranged in a linear series at the dorsal edge of the parapodia and ventrally at the base of the feet and in pairs on the mid-ventral line; the anterior surface of each pedal lobe has a single black spot in its centre. These spots show clearly only in well preserved specimens, but in all material they are present and even when some have disappeared, an overall pattern similar to that described can be visualized.

DISCUSSION. Chamberlin's (1919) records of *Rhynchonerella cincinnata* Greeff, 1876, from the Pacific must be considered as *K. lepidota* for although he does not describe the pigment spots he refers to the very long posterior tentacular cirri, which appear to be characteristic. Dales (1957) reports *Callizona pigmenta* Treadwell, 1943, as synonymous with *K. lepidota.*

GENERAL DISTRIBUTION. *K. lepidota* is known only from Tropical and Sub-Tropical waters (see below pp. 454–455).

Family TYPHLOSCOLECIDAE

Exclusively pelagic. Body spindle-shaped or cylindrical. Prostomium not distinctly marked off from the rest of the body. Nuchal organs well developed. Peristomium indistinct bearing one pair of cirri; the two succeeding segments also bear only one pair but thereafter there are two representing the dorsal and ventral cirri of the parapodia. Pedal mamelon reduced with an acicula and a few small simple chaetae sometimes present.

KEY TO GENERA

1. Prostomium with dorsal and ventral ciliated epaulettes . . . ***TYPHLOSCOLEX***
–. Prostomium without ciliated epaulettes 2
2. With a pair of nuchal organs which are attached to the body only along their anterior border; a caruncle may or may not be present . . . ***TRAVISIOPSIS***
–. With nuchal organs entirely attached to the body surface . . . ***SAGITELLA***

Genus *TYPHLOSCOLEX* Busch, 1851

Body spindle-shaped. Prostomium with dorsal and ventral ciliated epaulettes, the dorsal epaulettes carrying two lateral basal wings. Chaetae begin on the fifth parapodia. Protrusible proboscis.

Type species. *Typhloscolex mülleri* Busch, 1851.*

Type locality. Trieste.

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* See Addenda, p. 492.

Typhloscolex mülleri Busch, 1851

Typhloscolex mülleri Busch, 1851, pp. 115–116, pl. 11, figs. 1–6.
Typhloscolex Mülleri: Fauvel, 1923, pp. 226–227, fig. 85, *f–h*.
Typhloscolex Mülleri: Støp-Bowitz, 1948, pp. 17–18, fig. 8.
Typhloscolex mülleri: Uschakov, 1955, p. 112, figs. *a–c*.
Typhloscolex mülleri: Uschakov, 1957*a*, p. 286, Chart 4.
Typhloscolex mülleri: Dales, 1957, pp. 146–147, fig. 55, *a–b*.
Typhloscolex mülleri: Tebble, 1960, pp. 195–196 and pp. 231–236, figs. 34–36, Tables 16, 17.

DESCRIPTION. In Table IV the size range of specimens of *T. mülleri* collected on the Trans-Pacific Expedition at Stations 12A to 21B have been listed. This

TABLE IV.—*Typhloscolex mülleri**

Number of specimens between
1·5 mm. and 14·0 mm.
in length

Stn.														
21B	1	2	3	3	2	4	2	1	7	3	1	1	—	Sub-Arctic Zone
21A	—	—	—	2	2	—	2	1	1	4	1	—	—	
20B	—	—	—	2	—	—	4	3	3	3	1	2	2	
20A	1	—	4	7	3	11	6	1	2	1	—	1	—	
19B	—	—	—	—	—	2	2	1	1	4	3	2	1	
19A	—	—	4	2	3	2	—	—	1	—	—	—	—	
18B	—	1	1	—										Transition Zone
18A	—	—	1	—										
17A	—	—	2	2										
16E	—	—	—	1										
16B	—	—	—	1										
16A	1	—	1	1										
15B	—	1	—	—										
15A	—	1	—	—										
14B	—	2	—	—										Sub-Tropical Zone
14A	—	1	—	—										
13B	1	2	—	—										
13A	—	2	1	1										
12F	—	1	1	1										
12D	—	1	1	1										
12C	—	2	3	—										
12B	—	1	—	—										
12A	—	1	—	—										

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* This Table also shows the increase in numbers of *T. mülleri* caught in the Sub-Arctic Zone and that an ecotypic form of this species inhabits this zone; these points are examined in greater detail later.

line of stations crosses from the Sub-Tropical Zone through the Transition Zone into the Sub-Arctic Zone.

A finely pointed prostomial palpode projects between the dorsal and ventral ciliated epaulettes ; the latter are always as wide as the body width. The dorsal epaulette carries two basal wings which are proportionally larger in the bigger specimens. On each side of the peristomium are the first cirri, large and kidney-shaped, covering the epaulettes laterally. The next two segments carry one oval cirrus on each side ; thereafter foliaceous dorsal and ventral cirri are present on all segments up to the end of the body. Simple chaetae appear on the fifth parapodia. There is a pair of elliptical anal cirri.

Discussion. A most striking feature of the systematic analysis of these collections was the occurrence of specimens of *T. mülleri*, measuring up to 13–21 mm. in length, at stations made in the Sub-Arctic Zone. Samples from this zone were recognizable immediately through their presence ; they have been reported from nowhere else in the world. Almost all previous authorities accepted 2–7 mm. as the approximate size range of *T. mülleri*, only Uschakov (1955 and 1957*a*) having previously reported a larger size, 2–15 mm., and these from the Bering Sea, the Sea of Okhotsk and off the south-east coast of Kamchatka, within the Sub-Arctic Zone of the North Pacific.

Statistical analysis[1] of the data in Table IV indicated that the animals from the Sub-Arctic Zone on the one hand and the Transition and Sub-Tropical Zones on the other did not belong to the same population ($F = 21{\cdot}2$; d.f. 2,156 ; $P < 0{\cdot}001$) and that the Sub-Arctic Zone general mean (7·51 mm.) was significantly greater than the Transition Zone (4·57 mm.) which was non-significantly greater than the Sub-Tropical Zone (4·04 mm.). This final analysis also indicated that the Transitional and Sub-Tropical Zone data were homogenous whilst the sub-arctic data could be resolved into two populations the one with smaller individuals (4·2 mm.) being closely similar to that from the other zones, whilst the other had significantly greater (9·1 mm.) individuals.

As isolated specimens the larger forms in the Sub-Arctic Zone could have been described as separate species, relating specific characteristics only to gross size, but the presence of typical small forms is against this. The evidence from statistical analysis, however, suggests that there are two distinct populations, a population of small individuals, which is part of a population occurring in all three zones, and a population of large forms which is confined to the Sub-Arctic Zone. Presumably we have here an ecotypic variation (large forms adapted to the sub-arctic environment) mixed with members of a more widely distributed continuous series of contiguous populations.

General distribution. *T. mülleri* is a cosmopolitan species, having been reported from all explored water masses (see below, pp. 454, 456).

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[1] These analyses were carried out by Mr. D. E. Davies and involved in order, an analysis of variance, a sequential means test based on the error of variance derived from the first analysis, and tabulated upper 5% range tests followed by a polymodal graphical analysis due to Harding (1949). Statistical treatment of these data was first suggested by Dr. E. W. Fager of the Scripps Institution of Oceanography.

Genus *SAGITELLA* Wagner, 1872

Body spindle-shaped. Prostomium with nuchal organs which are entirely fixed to the body surface. Caruncle absent. Simple chaetae appearing from about the third to fifth parapodia.

Type species. *Sagitella kowalewskii* forme A. Wagner, 1872.

Type locality. Tropical Atlantic Ocean.

The second *w* in *kowalewskii* has frequently been altered to a *v*; there is no valid reason for altering the original orthography in this case and I therefore use the spelling *kowalewskii*.

Sagitella kowalewskii Wagner, 1872

Sagitella kowalewskii forme A Wagner, 1872, pp. 342–347, figs. A–C.
Sagitella kowalewskii: Fauvel, 1923, p. 228, fig. 85, *a–c*.
Sagitella kowalevskii: Støp-Bowitz, 1948, pp. 56–57, fig. 43.
Plotobia paucichaeta: Treadwell, 1943, p. 38, pl. 11, fig. 26.
Sagitella kowalewskii: Uschakov, 1957*a*, pp. 288–289, Chart 4.
Sagitella kowalevskii: Dales, 1957, pp. 147–148, figs. 56, 57, 60

Description. The largest specimen collected measures 19 mm. in length for about sixty pairs of parapodia and the smallest 2·0 mm. for thirty. The prostomium has a finely pointed palpode projecting anteriorly. The first three segments carry one foliaceous cirrus on each side. Between the first and second of these, on the dorsal surface, the nuchal organs form two boomerang-shaped ridges. Parapodia carry a pair of dorsal and ventral cirri, with simple chaetae first appearing on the third to fifth feet; these are clearly visible only on posterior segments where the segmentation is more clearly marked. The pygidium carries two spatulate anal cirri.

Discussion. I have examined a syntype of *Plotobia paucichaeta* Treadwell 1943, in the collections of the U.S.N.M., No. 130492, from 14° 52′ S., 126° 07′ W., and find it is a *Sagitella kowalewskii*: this confirms the opinion of Dales (1957). From Treadwell's description of *Plotobia paucichaeta* I thought it might be *Travisiopsis dubia* (q.v.).

General distribution. *S. kowalewskii* is known only from Tropical and Sub-Tropical waters (see below, pp. 454, 457–8).

Genus *TRAVISIOPSIS* Levinsen, 1885 (characters emended)

Body cylindrical or spindle-shaped. Prostomium with nuchal lobes which are free from the body over the greater part of their length; these normally flank a caruncle but in one species (*T. dubia*) a true caruncle is absent. The first three segments behind the head with single foliaceous cirrus on each side; thereafter parapodia with paired foliaceous cirri; only a few simple chaetae present on some parapodia.

Type species. *Travisiopsis lobifera* Levinsen, 1885.

Type locality. 42° 50′ N., 46° 10′ W.

This description of *Travisiopsis* is emended to include *Travisiopsis dubia* Støp-Bowitz, 1948, which was first described from two specimens collected by the *Michael Sars* in the North Atlantic. Sixteen more are reported here, and it is clear that this species though without a true caruncle (but only a thickening of the dorsal surface of the prostomium) is a *Travisiopsis* because it has two nuchal lobes which are free from the body over the greater part of their length. It differs, therefore, fundamentally from the closely related *Sagitella*, which has neither caruncle, nor free nuchal lobes, but has these latter organs entirely attached, forming distinct ridges.

KEY TO SPECIES

1. Caruncle absent	***T. dubia***
–. Caruncle present	2
2. Nuchal lobes branches	***T. coniceps***
–. Nuchal lobes not branched	3
3. Nuchal lobes long, finger-shaped	***T. lanceolata***
–. Nuchal lobes short	4
4. Caruncle round ; twenty-one segments	***T. lobifera***
–. Caruncle rectangular, twenty-five segments	***T. levinseni***

Travisiopsis lobifera Levinsen, 1885

(Text-fig. 19)

Travisiopsis lobifera Levinsen, 1885, pp. 336–340, figs. 17–20.
Travisiopsis lobifera : Fauvel, 1923, p. 229, fig. 86*a–d.*
Travisiopsis lobifera : Støp-Bowitz, 1948, pp. 57–58, fig. 44.
Travisiopsis lobifera : Uschakov, 1957*a*, pp. 286–287, Chart 4, fig. 7, *d–g*.
Travisiopsis lobifera : Berkeley & Berkeley, 1957, pp. 577–578.
Travisiopsis lobifera : Dales, 1957, pp. 148–149, figs. 58–60 (in part).
Travisiopsis lobifera : Tebble, 1960, pp. 196–197, fig. 13*a* ; p. 245, fig. 45.

DESCRIPTION. This species is cylindrical in shape and may measure up to 25 mm. long for a constant twenty-one segments. The median dorsal caruncle, attached on a level with the first cirri, is characteristically oval. Paired nuchal lobes surround the caruncle in the form of fixed processes anteriorly, and laterally, with free projecting lobes posteriorly which reach as far as the second cirri. The single cirri of the first three segments are circular—except for the incision at the point of attachment—thereafter the parapodial cirri are approximately heart-shaped. Simple acicular chaetae may appear from the fifth segment ; there are rarely more than three of these in a group and there may be only one. Anal cirri are elongate oval to rectangular in form.

DISCUSSION. Dales (1957) refers *Plotobia simplex* Chamberlin (1919) to *T. lobifera* but I agree with Støp-Bowitz (1948) that it is probably *T. lanceolata* (see below, p. 413).

GENERAL DISTRIBUTION. *T. lobifera* is known only from Tropical and Sub-Tropical waters (see below, pp. 458–459).

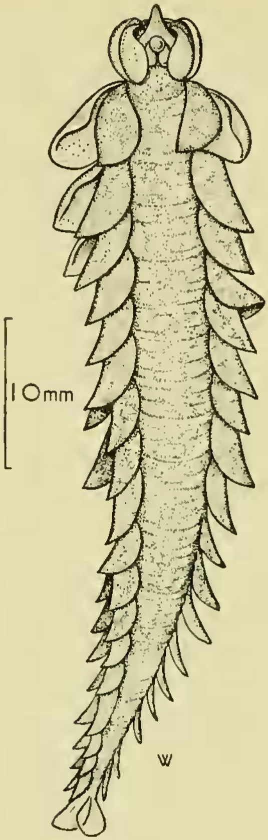

FIG. 19. *Travisiopsis lobifera :* specimen from Stn. 13B of the Trans-Pacific Expedition.

Travisiopsis levinseni Southern, 1910

Type locality. 53° 07′ N., 15° 09′ W., 650–750 fathoms (= 1,188·7–1,371·6 m.).

Travisiopsis levinseni Southern, 1910, p. 429.
Travisiopsis levinseni : Southern, 1911, pp. 32–33, pl. 2, figs. 7–10.
Travisiopsis levinseni : Fauvel, 1923, pp. 229–230.
Travisiopsis levinseni : Støp-Bowitz, 1948, pp. 59–60, fig. 46, fig. 47*a–b*.
Travisiopsis levinseni : Uschakov, 1955, p. 114, fig. 14*d–g*.
Travisiopsis levinseni : Uschakov, 1957*a*, p. 288, Chart 4.
Travisiopsis levinseni : Dales, 1957, p. 150.
Travisiopsis levinseni : Tebble, 1960, pp. 197–198, fig. 13*b* ; pp. 236–237, fig. 36.

DESCRIPTION. This species is spindle-shaped and may measure up to 35 mm. in length for a constant twenty-five segments. The median dorsal caruncle is attached on a level with the first cirri and is characteristically rectangular. Paired nuchal lobes border the caruncle laterally with free projecting semicircular lobes posteriorly, which reach as far as the second cirri. The single cirri of the first three segments are foliaceous; thereafter the paired parapodial cirri are rectangular, becoming lanceolate posteriorly. Simple acicular chaetae may appear from the sixth foot, with rarely more than three in a group. Anal cirri are long and oval.

GENERAL DISTRIBUTION. The records of this species from the North Pacific Ocean are too few to warrant drawing any firm conclusions about its distribution (see below, pp. 458, 461). In the South Atlantic Ocean *T. levinseni* has been reported in all hydrological zones (Tebble, 1960); its distribution in the North Atlantic Ocean has not been fully investigated.

Travisiopsis lanceolata Southern, 1910

Type locality. 51° 12′ N., 11° 55′ W., 500 fathoms (914·4 m.).

Travisiopsis lanceolata Southern, 1910, p. 429.
Travisiopsis lanceolata: Southern, 1911, pp. 30–32, pl. 1, figs. 3, 5, 6.
Plotobia simplex Chamberlin, 1919, pp. 155–156, pl. 65, figs. 6–11; pl. 66, fig. 1.
Travisiopsis lanceolata: Fauvel, 1923, p. 229, fig. 86, *e–g*.
Plotobia simplex: Treadwell, 1943, p. 38.
Travisiopsis lanceolata: Støp-Bowitz, 1948, pp. 58–59, figs. 45–46.
Travisiopsis lobifera: Dales, 1957, pp. 148–150, figs. 58–60 (in part).
Travisiopsis lanceolata: Tebble, 1960, pp. 198–199, fig. 13*c*; p. 246, fig. 45.

DESCRIPTION. This spindle-shaped species may measure up to 38 mm. in length for a constant twenty-two segments. The median dorsal caruncle is ∇ in shape; the anterior part is attached at the level of the first cirri, the posterior portion is free. Two long, finger-shaped, nuchal lobes surround the caruncle anteriorly, are free posteriorly and may reach to the fourth segment. Cirri on the first three segments are reniform, thereafter they are almost square becoming lanceolate posteriorly.

DISCUSSION. There can be little doubt that *Plotobia simplex* Chamberlin (1919) is synonymous with *T. lanceolata* as suggested by Støp-Bowitz (1948). Dales (1957) considers *P. simplex* synonymous with *T. lobifera* but Chamberlin's drawing (1919, pl. 66, fig. 1) shows the characteristic finger-shaped nuchal processes clearly.

GENERAL DISTRIBUTION. Chamberlin's (1919) record of *P. simplex* appears to be the first for *T. lanceolata* from the North Pacific where it is known from few records (see below, pp. 458, 461). In the South Atlantic Ocean *T. lanceolata* does not occur south of the Sub-Tropical Convergence but in the North Atlantic it has been reported from boreal waters, Wesenberg-Lund (1950, 1951).

Travisiopsis dubia Støp-Bowitz, 1948

(Text-fig. 20, ***a***, ***b***, ***c***)

Type locality. North Atlantic Ocean, 39° 30′ N., 49° 42′ W.

Travisiopsis dubia Støp-Bowitz, 1948, pp. 60–61, fig. 48, *a–e*.
Travisiopsis dubia: Dales, 1960, p. 485.

DESCRIPTION. The holotype of this species measures 6 mm. in length for twenty-eight segments and the paratype 10 mm. for twenty-three segments (Støp-Bowitz, 1948, both specimens in the Bergen Museum, Norway).

Of the sixteen specimens reported here the smallest measures 2·5 mm. in length for eighteen segments and the longest 6·5 mm. for twenty-six.

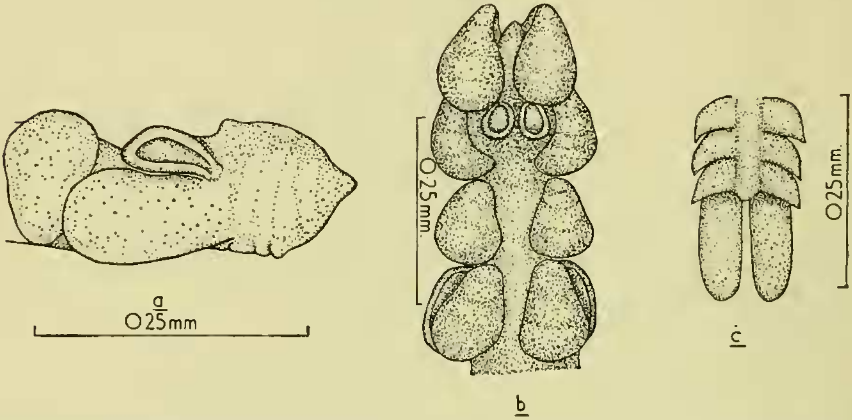

FIG. 20. *Travisiopsis dubia*: specimen from Stn. 92A of the Trans-Pacific Exp., (*a*) side view of head and anterior segments with the anterior pair of cirri omitted, (*b*) dorsal view of head and anterior segments, (*c*) dorsal view of posterior segments.

The slender body terminates anteriorly in a bulbous point. The dorsal nuchal lobes are attached along their anterior edge only, on a level with the anterior border of the second cirri; they are oval to semicircular with a rim along the outer edge. They do not border a caruncle but the dorsal surface of the prostomium in front of them is considerably thicker than elsewhere. The cirri on the first segments are circular and cover the front of the prostomium laterally, on the second segment they are elongate, broadly oval, with the long axis horizontal, and on the third segment also elongate, broadly oval but with the long axis vertical. The first group of paired parapodial cirri are lanceolate but from the middle body region become gradually quadrate up to the end of the body. Simple acicular chaetae appear between some parapodial cirri; there are never more than three of these in a group and they may not penetrate the body wall in posterior segments. Anal cirri are elongate, and curved at their free ends.

DISCUSSION. This is the first record of this species since its original discovery.[1] Dr. C. Støp-Bowitz kindly compared specimens I sent him with the type material and was able to confirm that they are *T. dubia*. There is no doubt that this species is superficially much closer to *Sagitella* than to *Travisiopsis* but it must be included in the latter species because of the free nuchal lobes. Støp-Bowitz (1948) notes this similarity but refers the species to *Travisiopsis* because of the possession of a caruncle. However, it is noted above that *T. dubia* does not have a true caruncle, merely a thickening of the dorsal surface of the prostomium and this character brings it closer still to *Sagitella*. Nevertheless, the possession of nuchal lobes, attached only along their anterior borders, but free posteriorly and not completely attached to form ridges as in *Sagitella*, is a distinctive generic difference and unequivocally establishes the species as a *Traviopsis*.

GENERAL DISTRIBUTION. *T. dubia* is known from very few records all of which are from Tropical and Sub-Tropical waters (see below, pp. 460, 461).

Family PHYLLODOCIDAE

Not exclusively pelagic. Body normally long and slender with numerous segments except in the pelagic genera in which it is short and wide and the number of segments may be fixed within narrow limits. Prostomium normally with eyes and antennae. Tentacular cirri present. Parapodia uniramous or biramous, with simple and/or compound chaetae; cirri normally present. Proboscis protrusible, usually with papillae, exceptionally with chitinous jaws. Anal cirri normally present.

Representatives of two subfamilies, all members of which are exclusively pelagic, have been collected; they may be separated as follows:

1. With no antennae. Two pairs of tentacular cirri. Proboscis may have chitinous jaws. Chaetae always compound . . . . IOSPILINAE
2. With four antennae. Two or three pairs of tentacular cirri. Proboscis never with chitinous jaws. Chaetae compound and simple . . . LOPADORHYNCHINAE

Subfamily LOPADORHYNCHINAE

KEY TO GENERA

1. Anterior parapodia modified dividing the chaetigers into two distinct regions (Text-fig. 21) . . . . *LOPADORHYNCHUS*
–. Anterior parapodia not modified 2
2. With four pairs of tentacular cirri (Text-fig. 23 . . . . . . *MAUPASIA*
–. With two pairs of tentacular cirri (Text-figs. 22 and 25) 3
3. Tentacular cirri with chaetae (Text-fig. 22) . . . . *PELAGOBIA*
–. Tentacular cirri without chaetae (Text-fig. 25) . . . . . *PEDINOSOMA*

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[1] In 1959 Dr. R. P. Dales sought my opinion about some specimens he had from the Malacca Straits which were identical with material I had already identified from the Scripps Collections as *Travisiopsis dubia*. Dr. Dales' paper was published whilst this present work was in manuscript (see Dales, 1960).

Genus ***LOPADORHYNCHUS*** Grube, 1855

(Emended Malaquin & Dehorne, 1907 pro *Lopadorrhynchus* Grube, 1855)

Prostomium with four antennae, two dorsal, which appear as anterior extensions of the lateral border, and two ventral, close to the mouth. Three pairs of tentacular cirri. Parapodia uniramous and modified anteriorly so that the chaetigers are divided into two distinct regions ; simple and compound chaetae are present supported by a prominent pedal lobe with acicula. Dorsal cirri present on all parapodia, ventral cirri may be absent on anterior feet. Proboscis smooth or papillate.

Type species. *Lopadorhynchus brevis* Grube, 1855.

Type locality. Mediterranean.

I have given elsewhere (Tebble, 1960) my reasons for not accepting the division of this genus into the subgenera *Lopadorhynchus sensu stricto* and *Prolopadorhynchus*.

Key to Species

1. The first three parapodia modified ; with simple chaetae only and no ventral cirri . . . ***L. brevis***
–. The first two parapodia modified : no ventral cirri 2
2. The first two parapodia robust and stout, with strong unidentate hooks, surrounded by a " ruff ", or collar . . . . ***L. uncinatus***
. The first two parapodia not robust or stout ; with simple unidentate hooks, without a ruff or collar . . . . ***L. krohnii***

Lopadorhynchus brevis Grube, 1855

Lopadorrhynchus brevis Grube, 1855, p. 100, pl. 3, fig. 15.
Lopadorrhynchus parvum Chamberlin, 1919, pp. 114–116, pl. 17, figs. 6, 7.
Lopadorhynchus brevis : Fauvel, 1923, p. 184, fig. 69*k*.
Lopadorhynchus (*Lopadorhynchus*) *brevis :* Dales, 1957, pp. 104–105, figs. 7–8.
Lopadorhynchus brevis : Tebble, 1960, pp. 200–201 ; pp. 259–261, fig. 52.

Description. The largest specimen collected measures 7 mm. in length for twenty-two chaetigers and the smallest 2·5 mm. for sixteen. The parapodia are divided into two separate regions at the posterior border of the third chaetiger. The prostomium is wider than long, with a straight anterior border with two long dorsal and two ventral antennae. Two eyes may be present but are not always clearly visible. There are three pairs of tentacular cirri, one dorsal and one ventral just behind the antennae and the third very small almost an appendage of the lower of these. The first three parapodia have no ventral cirri ; up to seven stout simple chaetae project, fan-wise, from a spatulate pedal lobe. Thereafter, compound chaetae, with oval terminal pieces on a pronounced heterogomph articulating surface, appear on all feet, with simple chaetae grouped ventrally becoming less numerous. On the fourth chaetiger there may be five to eight simple chaetae but on far posterior feet there may be none or only one. Dorsal cirri are foliaceous, ventral cirri smaller and subulate.

Discussion. The largest of the specimens reported here is smaller than those reported by Dales (1957) from the California Current, which measure up to 17 mm. in length, or by Tebble (1960) from the South Atlantic which reach 20 mm. in length. They differ from these also in other characters which would normally be associated with differences in stages of growth ; chaetae are neither as large nor so numerous, cirri are less well formed, and there are fewer chaetigers.

In my *Discovery* report (Tebble, 1960) I suggested that *L. nans* Chamberlin, 1919, was synonymous with *L. brevis* although Støp-Bowitz (1948) suggested it might be a synonym of *L. nationalis* Reibisch, 1895. In July, 1959, I examined the type specimen of *L. nans* in the Smithsonian Institution, Washington, U.S.N.M. No. 19402, and found it in poor condition and am unable to confirm either my own or Støp-Bowitz's opinion. At the same time I examined the type specimen of *L. parvum* Chamberlin, 1919, U.S.N.M. No. 19403 and found it similar to *L. brevis*.

General distribution. *L. brevis* is known only from Tropical and Sub-Tropical waters (see below, pp. 463, 465).

Lopadorhynchus uncinatus Fauvel, 1915

Original localities. From off the Azores and Monaco.

Lopadorhynchus uncinatus Fauvel, 1915, p. 3, fig. 2.
Lopadorhynchus uncinatus : Fauvel, 1923, pp. 184–185, fig. 67, *a–g*.
Lopadorhynchus varius Treadwell, 1943, pp. 32–33, pl. 1, figs. 7–10.
Lopadorhynchus (*Lopadorhynchus*) *uncinatus :* Støp-Bowitz, 1948, pp. 17–18, fig. 11.
Lopadorhynchus (*Lopadorhynchus*) *uncinatus :* Dales, 1957, pp. 101–104, figs. 1–6.
Lopadorhynchus uncinatus : Tebble, 1960, p. 201 ; pp. 259–261, fig. 52.

Description. The largest specimen measures 21 mm. in length for twenty-six chaetigers and the smallest 6 mm. for twenty-four. The parapodia are divided into two separate regions at the posterior border of the second chaetiger. The prostomium is wider than long, pointed anteriorly with two long dorsal and two short ventral antennae. Two eyes may be present but they are not always clearly visible. The first two tentacular cirri are long and cirriform lying dorsally and ventrally just behind the antennae, the third is very small and subulate, situated on the ceratophore which supports the ventral pair. The first two parapodia are much more prominant than the rest, they are large, stout, and directed laterally, with up to seven strong unidentate simple hooks, surrounded by a ruff or collar and with a small dorsal cirrus but no true ventral cirrus. The succeeding feet are thin and paddle-shaped, and directed backwards, with chaetae grouped fan-wise about the pedal lobe. From the third parapodia both simple and compound chaetae are present but the latter gradually replace the former. The terminal article of the compound chaetae is ovate with serrations on one side ; the articulation is heterogomph. Dorsal cirri are short and conical, ventral cirri are smaller and subulate.

Discussion. As Dales (1957) notes *L. varius* Treadwell, 1943, is almost certainly synonymous with *L. uncinatus*.

General distribution. *L. uncinatus* is known only from Tropical and Subtropical waters (see below, pp. 463, 465).

Lopadorhynchus krohnii (Claparède), 1870*

(Text-fig. 21)

Type locality. Naples.

Hydrophanes krohnii Claparède, 1870, pp. 464–466, pl. 11, fig. 2.
Lopadorhynchus krohnii : Fauvel, 1923, pp. 185–186, fig. 69*a–d*.
Lopadorhynchus (*Lopadorhynchus*) *krohnii* : Dales, 1957, pp. 105–106, figs. 9, 10.
Lopadorhynchus krohnii : Tebble, 1960, p. 202 ; pp. 259–261, fig. 52.

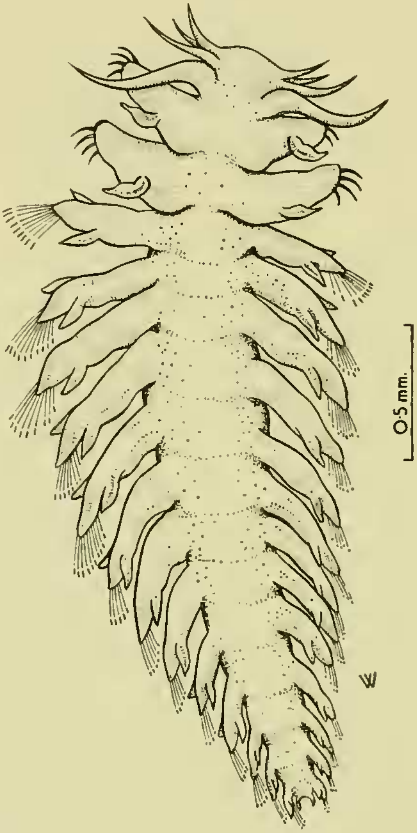

FIG. 21. *Lopadorhynchus krohnii :* specimen from Stn. 123A of the Trans-Pacific Exp.

DESCRIPTION. The largest specimen collected measures 9 mm. in length for twenty chaetigers and the smallest 1·5 mm. for eleven. The parapodia are divided into two distinct regions at the posterior border of the second chaetiger. The prostomium is twice as wide as long, with a rounded anterior border and two long dorsal and two short ventral antennae. No eyes are visible in any of the specimens. There are two long, dorsal and ventral pairs of tentacular cirri, and on the ceratophore at the base of the ventral pair there is a minute pimple, which must be regarded as a third tentacular cirrus. The first two chaetigers are directed laterally and are shorter and stouter than the rest ; they have simple hooked chaetae and a dorsal cirrus but no ventral cirrus. The remaining parapodia are directed posteriorly and are thin and paddle-shaped with small dorsal and ventral cirri ; chaetae are compound, with heterogomph articulation and serrated ovate terminal pieces, grouped fan-wise about the pedal lobe.

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* See Addenda, p. 492.

Discussion. This description differs from that in all previous descriptions of this species in noting the presence of a minute third tentacular cirrus. In re-examining the specimens of *L. krohnii* reported in Tebble (1960) from the South Atlantic I see that these also have this organ, as do those reported by Dales (1957), from the California Current, and material in the University Museum, Copenhagen from the North Atlantic.

General distribution. *L. krohnii* is known only from Tropical and Sub-Tropical waters (see below, pp. 463, 464).

Genus ***PELAGOBIA*** Greeff, 1879

Prostomium with four antennae. Two pairs of tentacular cirri with chaetae. Parapodia uniramous with dorsal and ventral cirri cylindrical (dorsal cirrus reduced or absent on the second chaetiger) and compound chaetae. Proboscis smooth. Pygidium with two cirri.

Type species. *Pelagobia longicirrata* Greeff, 1879.

Type locality. Arrecife, Canary Islands.

Pelagobia longicirrata Greeff, 1879

(Text-fig. 22)

Pelagobia longicirrata Greeff, 1879, pp. 247–249, pl. 14, figs. 23–25.
Pelagobia longicirrata : Fauvel, 1923, p. 192, fig. 72, *a*, *c*.
Pelagobia longicirrata : Støp-Bowitz, 1948, p. 21.
Pelagobia longicirrata : Uschakov, 1957*a*, p. 268, Chart 1.
Pelagobia longicirrata : Dales, 1957, pp. 107–108, figs. 11–13.
Pelagobia longicirrata : Tebble, 1960, pp. 202–204 ; pp. 237–242, figs. 37–44, Tables 18, 19.

Description. This species measures up to 12 mm. in length for fifteen to thirty chaetigers. The prostomium is approximately cone-shaped, truncated anteriorly, with two eyes and four small antennae. At the lateral posterior corners of the prostomium there are two shoulders which may carry numerous pigmented spots. The two pairs of tentacular cirri are long and subulate, between each is a pedal mamelon with compound chaetae. There is a ventral cirrus but no dorsal cirrus on the second chaetiger (counting the segment carrying the tentacular cirri as the first chaetiger). Thereafter parapodia have long cylindrical dorsal and ventral cirri. All chaetae are compound with smooth shafts but the terminal articles are denticulated along one edge. Anal cirri are short and blunt.

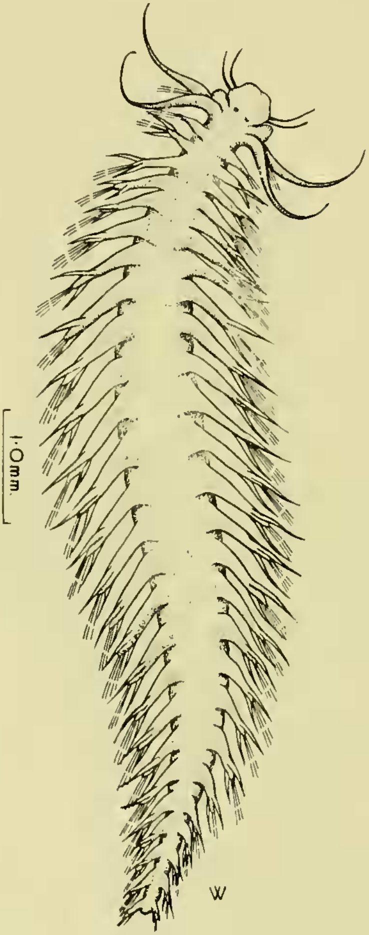

Fig. 22. *Pelagobia longicirrata :* specimen from Stn. 42E of the Trans-Pacific Exp.

General distribution. *P. longicirrata* is known from almost all explored water masses throughout the world (see below, pp. 460, 462).

Genus ***MAUPASIA*** Viguier, 1886

Prostomium with four antennae. Four pairs of tentacular cirri. Parapodia uniramous with dorsal and ventral cirri and compound chaetae only. Proboscis smooth.

Type species. *Maupasia caeca* Viguier, 1886.

Type locality. Bay of Algiers.

Maupasia caeca Viguier, 1886

(Text-figs. 23, 24)

Maupasia caeca Viguier, 1886, pp. 382–385, pl. 21, figs. 14–20.
Maupasia caeca: Fauvel, 1923, pp. 190–191, fig. 171*a–d*.
Maupasia caeca: Uschakov, 1957*a*, pp. 268–269, Chart 1, fig. 1, *c–e*.
Maupasia caeca: Tebble, 1960, pp. 204–205; p. 242, fig. 44.

Description. The largest specimen collected measures 7·5 mm. in length for twenty chaetigers and the smallest 2 mm. for twelve (in these counts the segments carrying the tentacular cirri, which always bear chaetae, have been counted as chaetigers). The prostomium is as wide as long and carries two dorsal and two ventral antennae. There are four pairs of tentacular cirri arranged thus, 1/1 + 1/1, on successive segments behind the head. The anterior pairs are pointed and as long as the width of the prostomium; the posterior dorsals are almost twice as long as these and the posterior ventrals about the same length or a little smaller. Groups of compound chaetae project from between each pair of tentacular cirri. Immediately in front of the tentacular cirri, but behind the antennae, a group of cirriform vibratile organs may be visible. These are retractile and may not always be protruding but the pit from which they emerge can always be detected. The first true parapodia appear immediately behind the tentacular cirri. On all parapodia dorsal cirri are cordiform with an extended tip or as Viguier (1886) described them " en forme de coeur irregulier "; ventral cirri are elongate and the pedal lobes lanceolate but all cirri may become swollen and mis-shaped in appearance in specimens carrying eggs. All chaetae are compound with a pronounced heterogomph articulation.

Discussion. The method of counting tentacular cirri in this genus needs clarification, for which comparison with other polychaetes is necessary. Considering the definition of *Nereis* by Fauvel (1923: 328), this genus has altogether eight tentacular cirri, four on each side of the peristomium, that is, four pairs. This is universally accepted today and the same method of counting is applied to all families of Polychaeta. Fauvel (1923) in defining *Maupasia*, however, notes that it has three pairs of tentacular cirri and therefore we would expect it to have six altogether, three on each side, but, in fact, from Fauvel's description of *M. caeca*, it appears to have twelve altogether; that is, six pairs and not three. Fauvel (1923) takes this count from Viguier's (1886) original description, which was prepared before a common method of counting tentacular cirri was adopted. I explain below, however, why

M. caeca has, in fact four pairs of tentacular cirri (equivalent to two pairs in Fauvel's description) and not six pairs (equivalent to the three pairs in Fauvel's account).

Since Viguier's original account of *M. caeca* all authorities have accepted that this species has three pairs of tentacular cirri on each side of the body, i.e., twelve altogether. In reading Viguier's account, however, it is clear that he counted the first pair of parapodial cirri as a third pair of tentacular cirri on each side. Furthermore, Viguier's original figure (1886, pl. xxi, fig. 15) shows only two pairs on each side, i.e., eight altogether, although the presence of vibratile organs may have confused the issue. It is singular that Fauvel does not mention these vibratile organs because his figure, which was taken directly from Viguier's work, shows them. Fauvel, however, would certainly not mistake parapodial cirri for tentacular cirri and I think he got his third pair of tentacular cirri on each side by counting a pair of the vibratile organs. Occasionally only one of these protrudes on either side (although

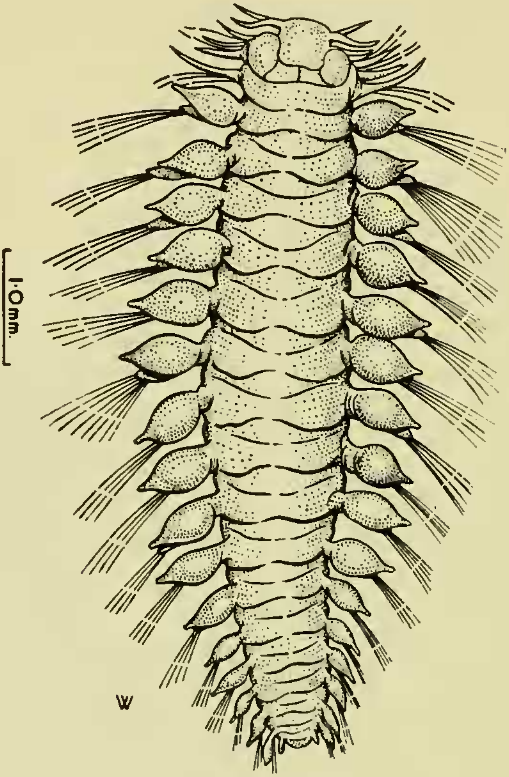

FIG. 23. *Maupasia caeca :* Specimen from Stn. 27B of the Trans-Pacific Exp.

there may be up to eight showing sometimes) and if so they answer perfectly to Fauvel's description of the most anterior pair of tentacular cirri in *Maupasia* thus : " une dorsal et une ventrale sur le premier segment, soude au prostomium et pourvu d'acicules et de soies ".

In making this correction to the definition of *M. caeca* I have examined material from the North Atlantic in the collections of the University Museum, Copenhagen, and that reported from the southern hemisphere by Ehlers (1912), Benham (1927), Hardy & Gunther (1935) and Tebble (1960).

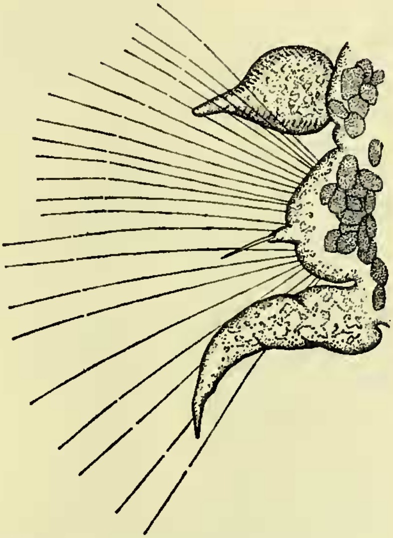

FIG. 24. *Maupasia caeca :* parapodium from the sixth chaetiger of specimen from Stn. 34B of the Trans-Pacific Exp.

GENERAL DISTRIBUTION. The first records of *M. caeca* from the North Pacific were made recently by Uschakov (1957*a*), at 48° 08′ N., 156° 08′ E. and Berkeley & Berkeley (1958) from 1° 58′ N., 83° 49′ W. Elsewhere in the world it has been recorded from scattered localities (see below, pp. 463, 466–467).

Genus ***PEDINOSOMA*** Reibisch, 1895

Prostomium with four antennae. Two pairs of tentacular cirri, without chaetae between them. Parapodia uniramous with round to ovate dorsal cirri and cylindrical ventral cirri and compound chaetae only. Proboscis smooth.

Type species. *Pedinosoma curtum* Reibisch, 1895.

Original localities. Tropical South Atlantic and Tropical and Sub-Tropical North Atlantic Oceans.

Pedinosoma curtum Reibisch, 1895

(Text-figs. 25, 26)

Pedinosoma curtum Reibisch, 1895, p. 21 ; pp. 27–30, pl. II, fig. 17 ; pl. III, figs. 1–4.
Pedinosoma curtum : Fauvel, 1923, pp. 188–189, fig. 70, *c–f*.

DESCRIPTION. The largest specimen collected measures 3·0 mm. long for eight chaetigers, this is a mature female, the body cavity being filled with eggs ; the smallest is 1·0 mm. in length for seven chaetigers. The prostomium is a little wider than long with two pairs of thin and pointed antennae projecting laterally from the anterior lateral corner. There are two pairs of tentacular cirri, all a little longer than the body width and finely pointed : no chaetae are associated with these. Of the thirteen specimens reported here all have eight chaetigers except two, which have seven. Parapodia have round to ovate dorsal cirri and finely pointed cylindrical

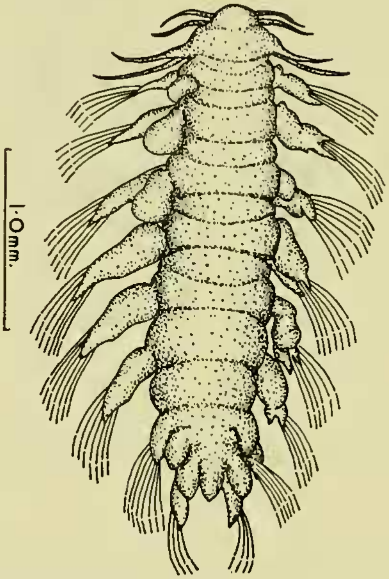

FIG. 25. *Pedinosoma curtum* : specimen from Stn. 49 of the Northern Holiday Exp. (the dorsal cirri have fallen off some segments).

ventral cirri; pedal lobes are lanceolate and carry a large number of compound chaetae, in which the articulation is heterogomph.

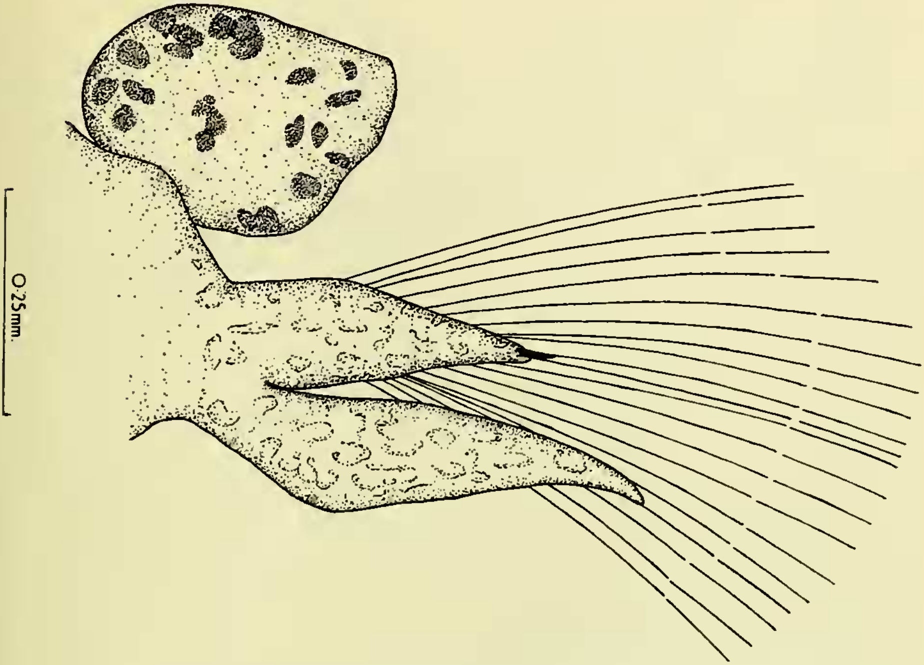

FIG. 26. *Pedinosoma curtum*: parapodium from the fourth chaetiger of specimen from Stn. 8 of the Northern Holiday Exp.

GENERAL DISTRIBUTION. This appears to be the first record of this species from the Pacific Ocean (see below, pp. 466, 467); it is known only from Tropical and Sub-Tropical waters in the Atlantic.

Subfamily IOSPILINAE

Genus ***PHALACROPHORUS*** Greeff, 1879

No antennae. Two pairs of tentacular cirri, of which the posterior carries chaetae. Parapodia uniramous, dorsal and ventral cirri small, compound chaetae with smooth terminal articles. Proboscis with two long chitinous teeth.

Type species. *Phalacrophorus pictus* Greeff, 1879.

Type locality. Canary Islands, Atlantic Ocean.

Phalacrophorus pictus Greeff, 1879

(Text-fig. 27*c*)

Phalacrophorus pictus Greeff, 1879, p. 249, pl. 14, figs. 25–30.
Phalacrophorus pictus : Reibisch, 1895, pp. 10–12, pl. 1, figs. 4–7.
Phalacrophorus borealis Reibisch, 1895, pp. 12–13, pl. 1, figs. 8–9.
Phalacrophorus pictus : Fauvel, 1923, p. 196, fig. 72*f*.
Phalacrophorus maculatus Treadwell, 1943, p. 34, pl. 1, figs. 11–13.
Phalacrophorus pictus : Uschakov, 1957*a*, pp. 274–275, fig. 1.
Phalacrophorus pictus : Hartman, 1956, p. 276.

Description. No complete specimens of this species were collected ; the largest fragment measures 7 mm. in length for thirty chaetigers. The prostomium is bluntly rounded with no eyes visible in any of the specimens. The proboscis carries two chitinous unidentate teeth. The segmentation of the first three segments is indistinct and, when the proboscis is not everted, this part of the body is swollen. The first pair of tentacular cirri is very small and achaetous, the second longer, with a few associated chaetae. This chaetiger and the next two are poorly developed but thereafter fully developed parapodia occur, with small bulbous dorsal cirri, smaller ventral cirri, and with prominently projecting pedal lobes carrying bundles of compound capillary chaetae. These chaetae have long finely pointed terminal articles. A number of specimens have the body cavity filled with eggs.

Discussion. These specimens differ from typical *P. pictus* in being without eyes and are thus close to *P. borealis* Reibisch, 1895 ; this is the only difference between these species and I do not consider that it merits separating them. In all other essentials this material is identical with two specimens of *P. pictus* in the B.M. (N.H.) collections, one reported by Fauvel (1916) from the Canaries and the other identified by Monro from *Discovery* collections, " William Scoresby ", Stn. 63, near South Georgia, but not previously reported.

General distribution. *P. pictus* is known from localities scattered thoughout the world, but it is possible that a separate population inhabits sub-arctic and arctic waters of the Pacific and Atlantic Oceans (see below, pp. 466, 468–9).

Phalacrophorus uniformis Reibisch, 1895

(Text-figs. 27*a*, *b*)

Original localities. Tropical South Atlantic and Tropical and Sub-Tropical North Atlantic.

Phalacrophorus uniformis Reibisch, 1895, pp. 15–17, pl. 1, figs. 10–16.
Phalacrophorus uniformis : Fauvel, 1923, pp. 196–197, fig. 72, *g*, *h*.
Phalacrophorus attenuatus Treadwell, 1943, p. 34, fig. 14.
Phalacrophorus uniformis : Hartman, 1956, p. 276.

Description. Only fragments of this species were collected, the longest measuring 4 mm. for about sixty chaetigers. The prostomium is bluntly rounded and has

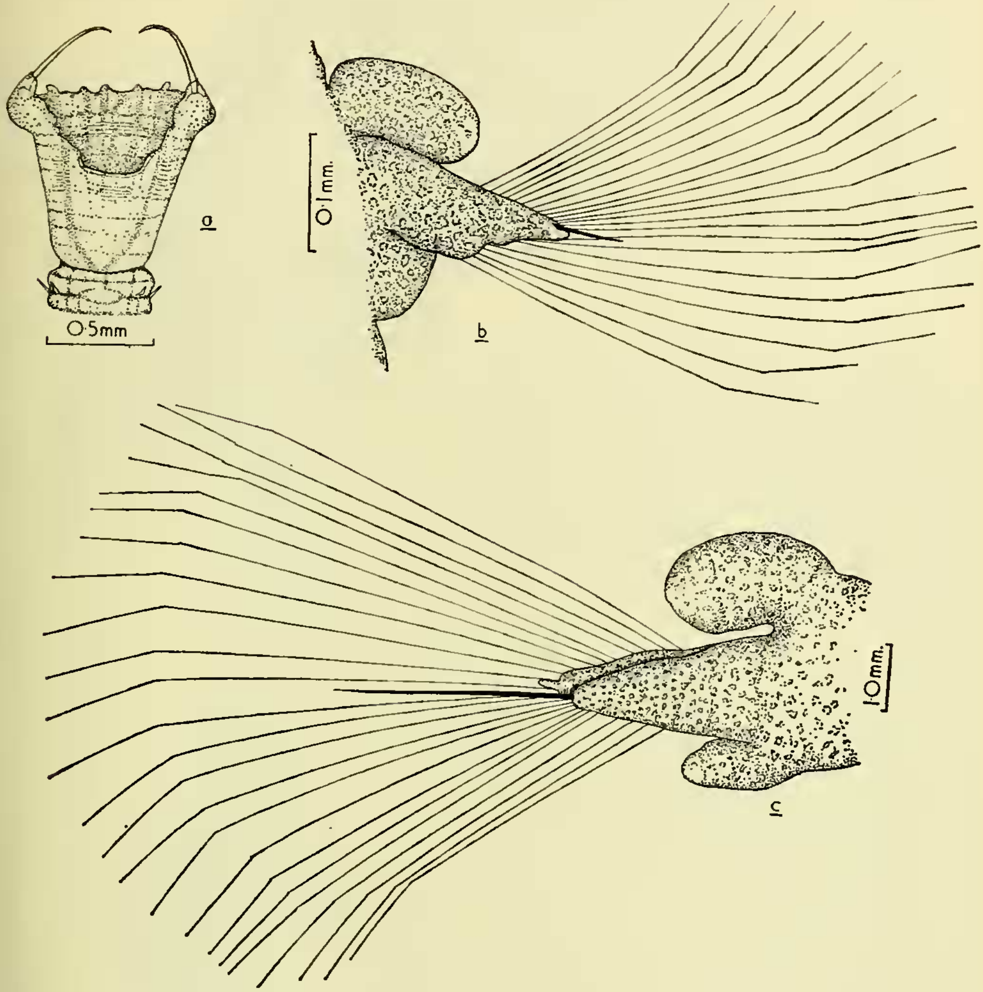

FIG. 27. *Phalacrophorus*: (*a*) *P. uniformis*, extruded proboscis of specimen from Stn. 126B of the Trans-Pacific Exp., (*b*) the same specimen, parapodium from the 128th chaetiger; (*c*) *P. pictus* parapodium from the twelfth chaetiger of specimen from Stn. 37B.

two small brown eye spots posteriorly. The proboscis carries two chitinous unidentate teeth. The segmentation of anterior segments is distinct on the dorsal surface but tends to be hidden ventrally. The first pair of tentacular cirri is small and the second longer, bearing a few chaetae. Thereafter the first eight to twelve chaetigers are poorly developed with very few, small compound chaetae and much reduced cirri, but succeeding parapodia have very long chaetae and better developed cirri.

Discussion. Hartman (1956) has examined the type specimen of *P. attenuatus* Treadwell, 1943, and considers it agrees with *P. uniformis* in important characters.

General distribution. *P. uniformis* is known from only a few scattered localities in the Pacific Ocean (see below, pp. 466, 468) but is well known in the Tropical and Sub-Tropical waters of the North Atlantic.

DISTRIBUTION

The families are examined below in the order followed in the Systematic Account, but genera and species have been arranged to meet zoogeographical considerations. Distribution maps have been prepared for all species. These generally indicate the presence or absence of a species at each station without an indication of the quantitative distribution because most pelagic polychaetes rarely occur in large enough numbers to make this necessary. *Tomopteris elegans*, *T. septentrionalis* and *Typhloscolex mülleri*, however, do occur in large and varying quantities and the relative abundance of these three species has been plotted.

Tomopteridae

Seven species of *Tomopteris* are reported here of which five, *T. elegans*, *T. planktonis*, *T. ligulata*, *T. nisseni* and *T. apsteini*, have never been collected in the Sub-Arctic Zone and it is clear that the southern boundary of this region or the southern boundary of the Transition Zone, indicates the limit of their northerly movement in the Pacific Ocean ; one species, *T. pacifica*, was collected only in the Sub-Arctic Zone and may be restricted to it ; and the remaining species *T. septentrionalis* was found in all three hydrological zones, substantiating its known cosmopolitan distribution.

T. elegans was collected at numerous stations across the Sub-Tropical Zone and was also found in the Transition Zone in the eastern region of the North Pacific (Text-fig. 28). It may be concluded therefore that this species has its northerly limit of distribution at the southern boundary of the Sub-Arctic Zone, though further collections may show that it extends farther north in the eastern region of the Transition Zone than in the western. There are no records in the literature which contradict this conclusion ; Izuka (1914) reported *T. elegans* from Sub-Tropical water off Japan, and Uschakov (1957*a*) records it from similar water between 35 and 40° N., in the region of 150° E. ; Dales (1957) notes it great abundance in the California Current. Elsewhere in the world *T. elegans* is known only from Tropical and Sub-Tropical waters.

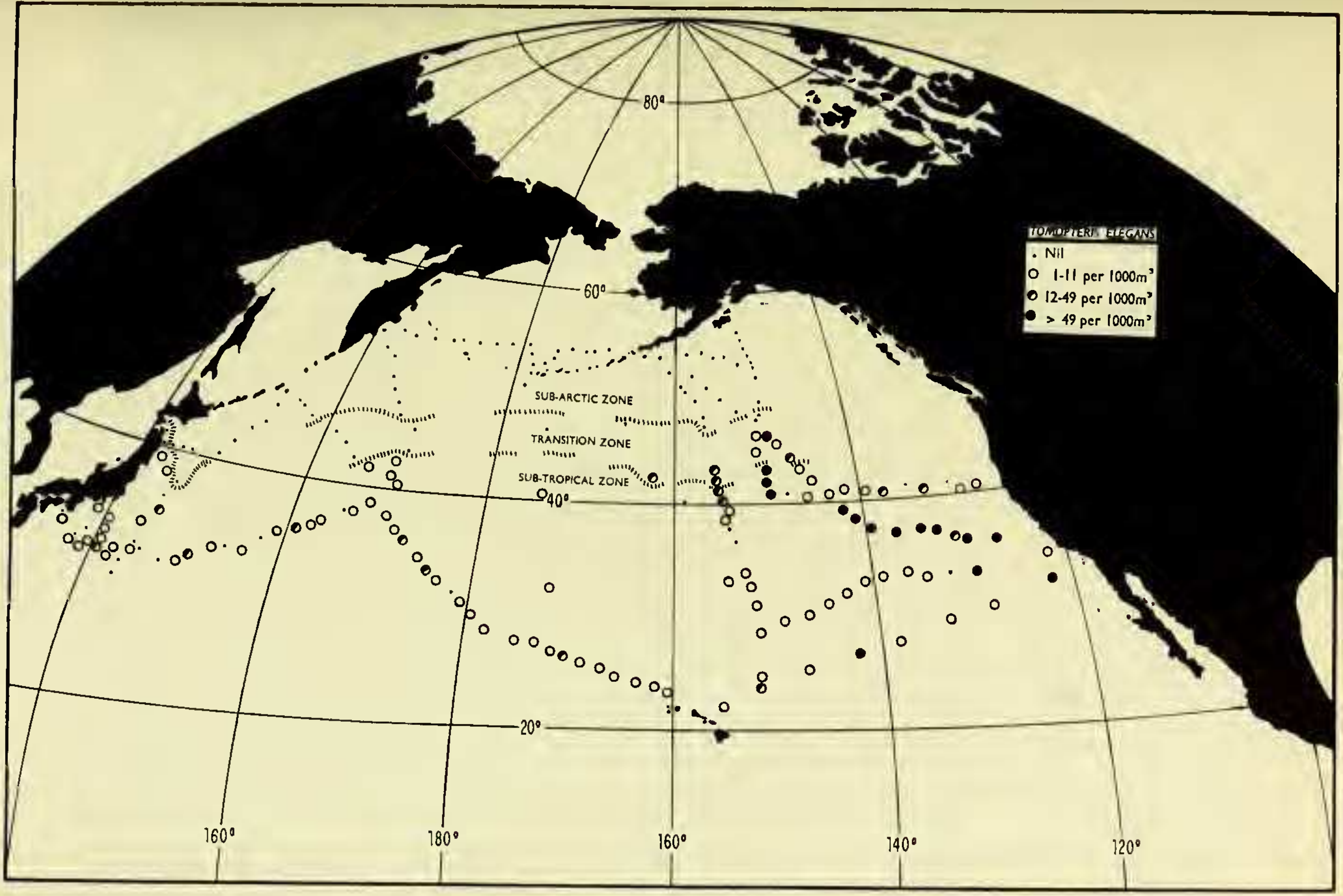

FIG. 28. Occurrence of *Tomopteris elegans*.

The samples examined by Dales from the California Current were collected in the top 75 metres of water, but the Trans-Pacific Expedition explored a greater depth range in this region and its samples show that *T. elegans* occurs in abundance down to about 350 metres. Below this depth, to 680 metres, however, there is a reduction in numbers caught, to negligible quantities. *T. elegans* is evidently also more abundant in the California Current, and the area immediately to the west, than elsewhere in the North Pacific. Across the breadth of the ocean it occurred regularly, though never in great abundance, in the North Pacific Central Water Mass down to 350 metres. Below this depth it was absent from all closing nets.

There is probably a significant relationship between the distribution of *T. elegans* and *T. septentrionalis* in the eastern North Pacific, including the California Current ; this is discussed below.

T. septentrionalis was collected in all three hydrological regions occurring in greatest abundance in the Sub-Arctic Zone (Text-fig. 29). It was caught regularly in the Sub-Arctic Water Mass down to about 400 metres but rarely occurred below this depth. Across the Sub-Tropical Zone *T. septentrionalis* appeared infrequently and then only in the upper layers of water. The few records from this zone may be due to the poor state of preservation of some of the collections.[1]

T. septentrionalis has been widely reported from the North Pacific, from off Misaki, Japan (Izuka, 1914), from off British Columbia (Berkeley, 1924 ; Berkeley & Berkeley, 1948), from Tropical, Sub-Tropical and Sub-Arctic waters (Treadwell, 1943), from the Bering Sea, the Sea of Okhotsk, and across the Sub-Tropical and Sub-Arctic Zones (Uschakov, 1955, 1957*a*), from Monterey Bay and the California Current (Dales, 1955, 1957) and from the Gulf of Alaska (Berkeley & Berkeley, 1957). These records are from all explored depths, and, with the summaries of the distribution of *T. septentrionalis* from elsewhere in the world made by Støp-Bowitz (1948) and Tebble (1960), have established the species as cosmopolitan.

I give reasons below for suggesting that in the California Current, and adjacent areas in the eastern North Pacific, *T. elegans* and *T. septentrionalis* may be mutually exclusive. Their relative distribution at all depths at the first thirteen stations on the Trans-Pacific Expedition is shown in the bar-diagram Text-fig. 30. These stations cross through the California Current to the northern edge of the Sub-Tropical Zone. Where one of these species occurs in abundance the other appears in only negligible quantities, if at all. Except at Stn. 1, *T. elegans* is always the more abundant. If the results obtained by Dales (1957) from samples taken entirely in the top 75 metres of water in the California Current are analysed a somewhat similar picture emerges. Thus Text-fig. 31 (a combination of the essentials in Dales' figs. 53 and 54) shows only a small region where the two species occur together, at intensities of distribution varying between <100 to 50 per 1,000 m^3 for *T. elegans* and >100 to 25 per 1,000 m^3 for *T. septentrionalis*. Dales does not give details of

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[1] In tomopterids the organs most affected by poor preservation are the parapodial pinnules. If these are incomplete in *T. septentrionalis* identification is difficult. It is very probable therefore that a large number of the specimens listed as " *Tomopteris* not identifiable ", in the Appendix could have been called *T. septentrionalis* if in a better state of preservation. Other species of *Tomopteris*, within the same size range as *T. septentrionalis*, clearly must also fall within this category sometimes, but on the whole they have more readily distinguishable features and can be recognized from other parts of the body even when the pinnules are frayed.

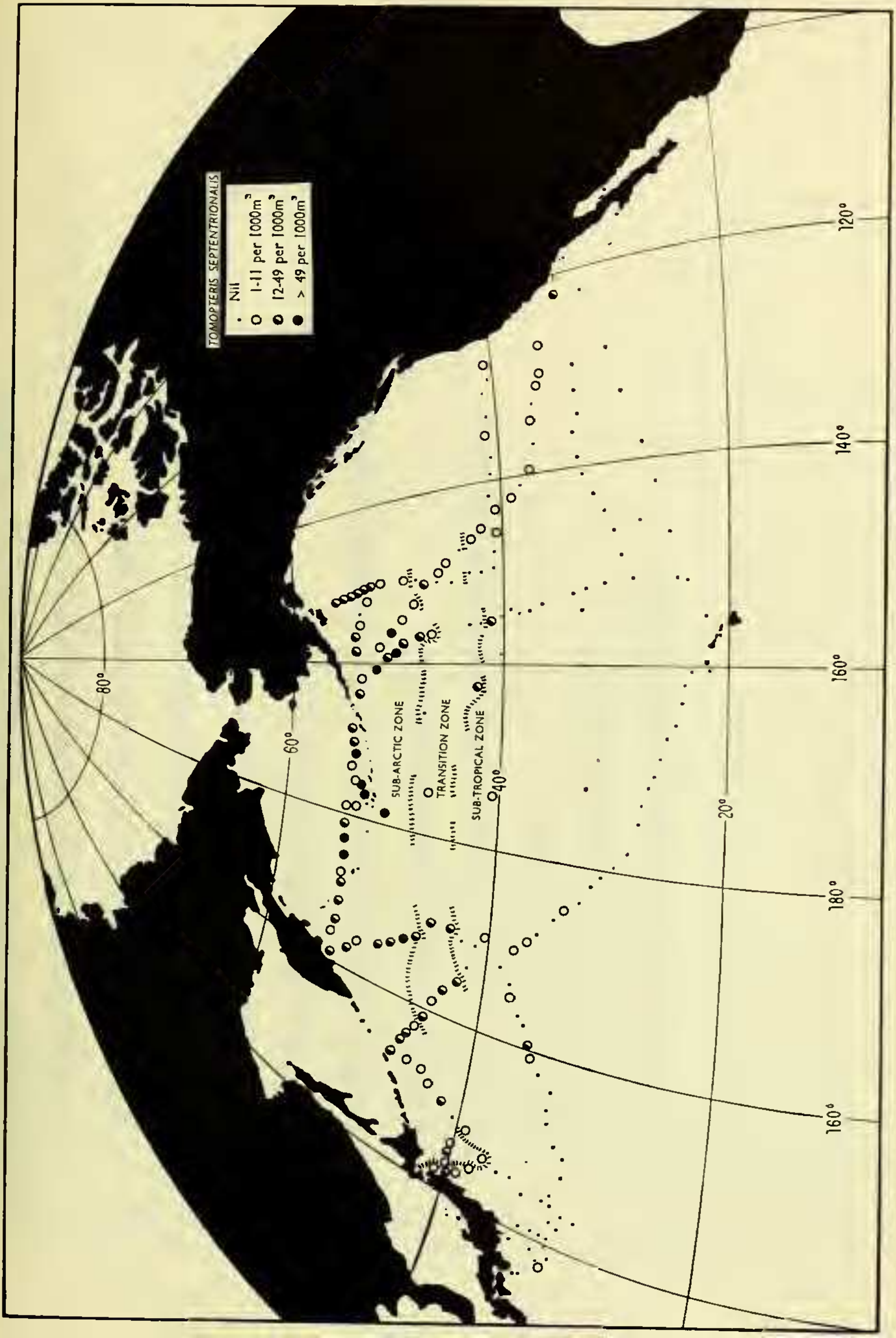

FIG. 29. Occurrence of *Tomopteris septentrionalis*.

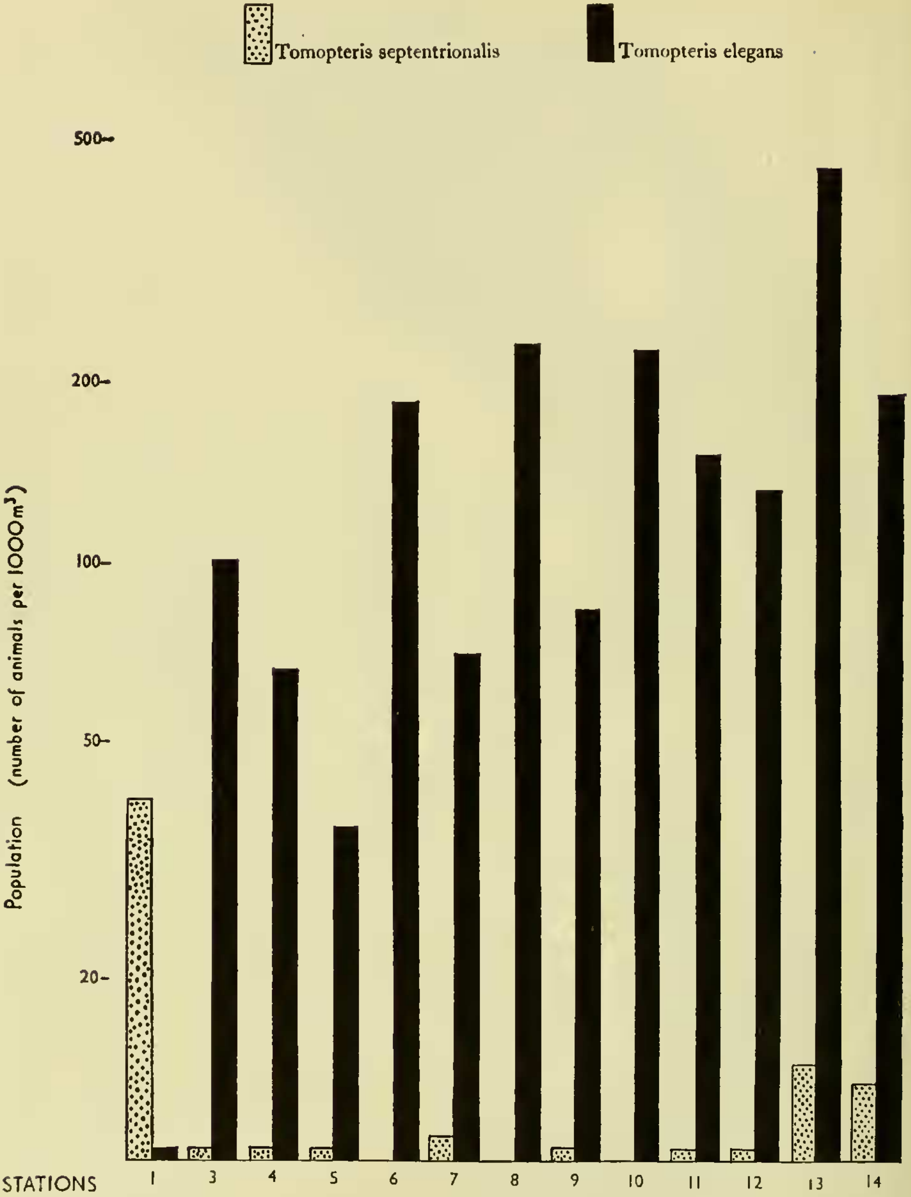

FIG. 30. Bar diagram showing the relative distribution of *T. septentrionalis* and *T. elegans* at the first thirteen stations of the Trans-Pacific Exp. (semi-log scale).

his results so that the actual number of stations where they occur together is not known but it must be small. Over the greater part of the region, and at the majority of stations, however, it is clear that where one species was collected in abundance the other was rarely present. Dales concludes from his data for *T. septentrionalis* that it is a cold water coastal form ; in fact, as noted above it is cosmopolitan, having been reported from all extremes of hydrological conditions. It is possible that where *T. elegans* occurs in abundance *T. septentrionalis* does not find conditions suitable for developing large populations. Because *T. elegans* is essentially a warm water form (i.e., it is confined to Tropical and Sub-Tropical waters), *T. septentrionalis* is forced into relatively colder waters whenever conditions exist where it could exist in abundance if *T. elegans* were not present. This appears to be applicable to distribution within the California Current and possibly westward to about

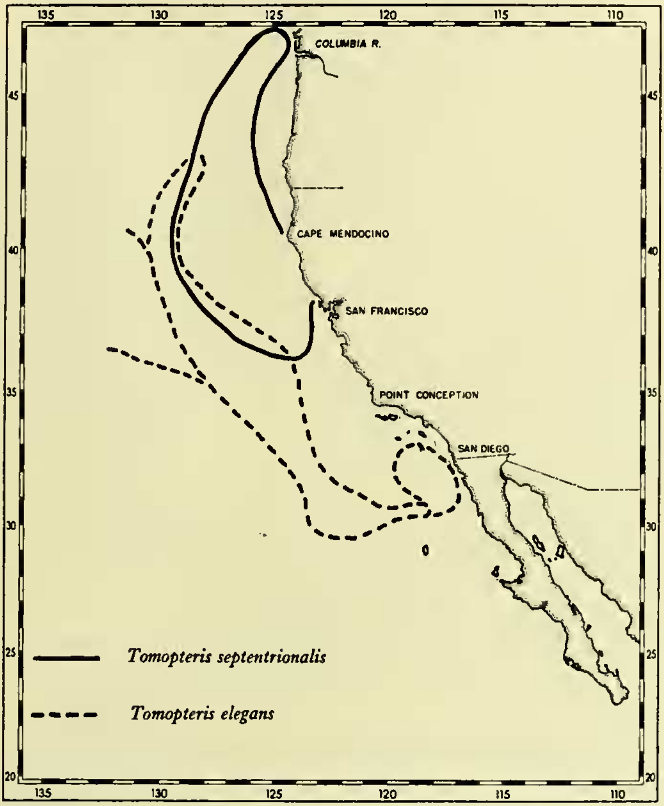

FIG. 31. Occurrence of *T. septentrionalis* and *T. elegans* in the region of the California Current (adapted from Dales (1957), figs. 53 and 54).

145° W.,[1] but no results are available to suggest it applies over the main body of North Pacific Central Water, or elsewhere in the world.

T. planktonis was collected at numerous stations, all within the Sub-Tropical and Transition Zones (Text-fig. 32) and it is clear that in the North Pacific this species must only rarely if ever cross the northern boundary of this latter region. It appeared only in nets towed open to the surface, and in closing nets towed between 370 and 120 metres, and must be essentially an inhabitant of the upper water layers. In only two samples were more than ten specimens collected ; at one of these, from Northern Holiday Stn. 55, twenty-two were present, equivalent to twenty-eight per 1,000 m³ of water.

Dales (1955) was the first to report *T. planktonis* from the North Pacific, recording it as *T. cavallii* from Monterey Bay ; under the same name he reported it from the California Current (Dales, 1957). Berkeley & Berkeley (1957) reported *T. cavallii* from the region of the Alaskan Gyral, about 55° N., 140° W., and although I have not examined this material it may be *T. planktonis*. Elsewhere in the world *T. planktonis* has been reported from the Antarctic by Augener (1929), Monro (1930 as *T. carpenteri*), Støp-Bowitz (1949, 1951) and Tebble (1960), from the Sub-Tropical and Tropical Atlantic by Apstein (1900), Monro (1936) and Tebble (1960) whilst Støp-Bowitz (1948) called it a bipolar species. It was expected therefore that *T. planktonis* would occur in some abundance in the North Pacific Sub-Arctic Zone, but it appears to be absent from this region, except as possibly a coastal migrant if future work shows that Berkeley & Berkeley (1957) records of *T. cavallii* are identical with the material reported here.

T. pacifica was collected only in the Sub-Arctic and Transition Zones (Text-fig. 33) and is probably restricted to colder waters in the North Pacific. It was rarely collected in abundance, normally there being only one or two specimens in a sample but ten were present in the catch made at Stn. 19B of the Trans-Pacific Expedition, equivalent to thirty per 1,000 m³ of water. Only nets towed open to the surface and those closing between 500 and 140 metres collected *T. pacifica*, so that at the present state of our knowledge it must be considered principally an inhabitant of the upper waters.

T. pacifica has previously been reported from the Sub-Arctic Zone of the North Pacific by Berkeley (1924, as *T. elegans*), Berkeley & Berkeley (1948, 1957 and 1960, as *T. renata*) and Uschakov (1952, 1955 and 1957*a* as *T. renata*). Dales (1955) reported it from deep water in Monterey Bay, which is probably the southern limit of its distribution along the west coast of the U.S.A.—he did not find it in the California Current. If there were no reports of this species from Sub-Tropical water in the North Pacific these records would substantiate the suggestion that it is a cold water species. There is, however, one,[2] the original description of *T.*

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[1] In this region *T. elegans* may never inhabit waters north of about 45° N., and care must therefore be taken to restrict examination of this relationship to waters of which both species are known to be tolerant. In Monterey Bay, for example, Dales (1955) found *T. septentrionalis* in abundance but does not report finding any specimens of *T. elegans*.

[2] Disregarding entirely Chamberlin's (1919) species called *T. eura*, which though superficially like *T. pacifica*, and reported from the Sub-Tropical Zone, is imperfectly described and cannot at the present time be accepted as the same species (see also Dales, 1957). Consequently Treadwell's (1943) records of *T. eura* must also be disregarded because he gave no additional information.

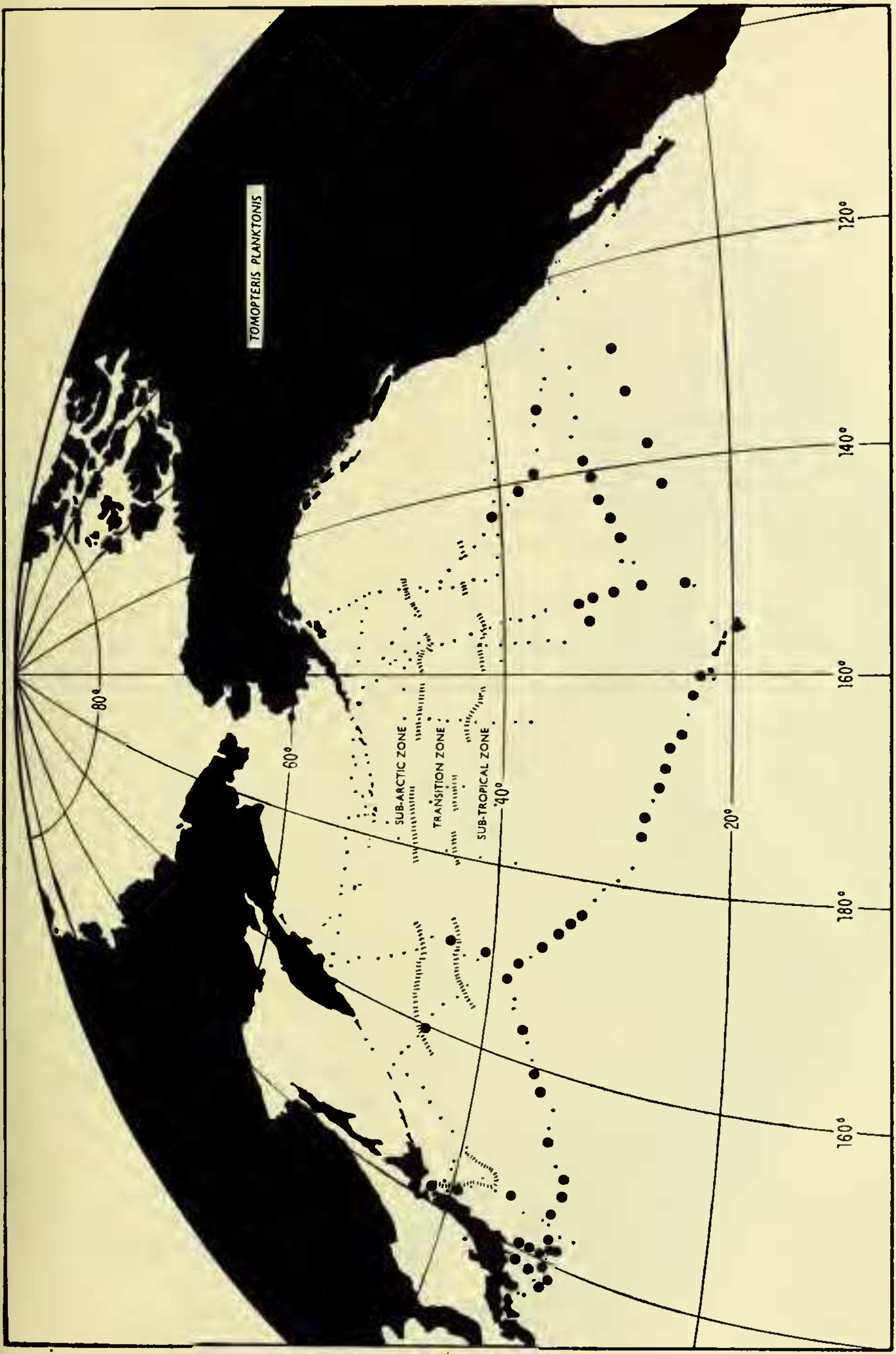

FIG. 32. Occurrence of *Tomopteris planktonis*.

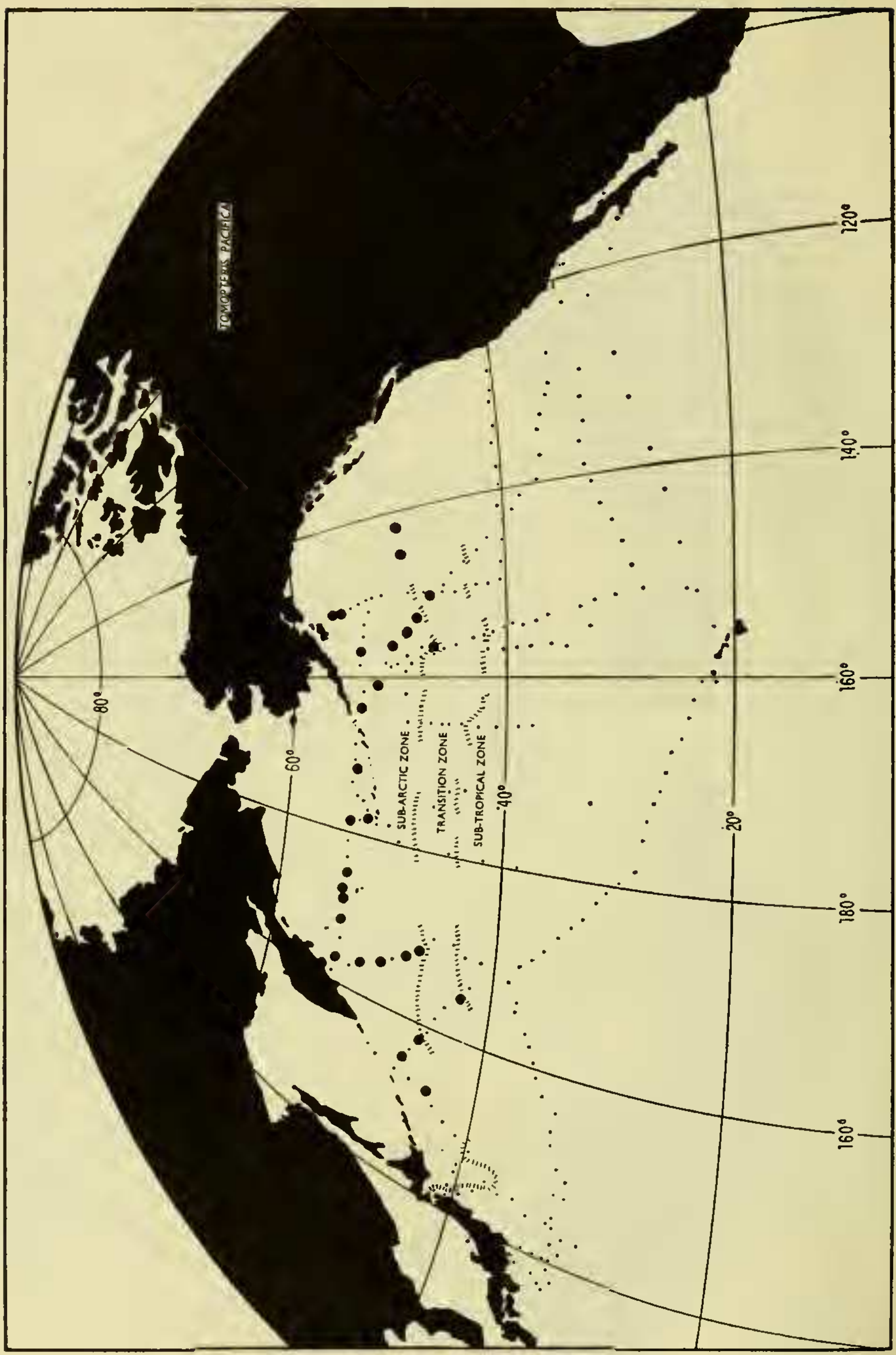

FIG. 33. Occurrence of *Tomopteris pacifica*.

pacifica having been made by Izuka (1914) from a sample collected off Misaka, Japan, in which there were also present six undoubtedly sub-tropical species, including *T. elegans* and *T. apsteini*. Undoubtedly Izuka was describing what is accepted as the valid species, *T. pacifica*, but the absence of any other undoubted records of it since that time from the Sub-Tropical Zone suggests that his record was anomalous, possibly the product of an aberrant coastal migration. It may be unfortunate that the type locality of this species is outside the limits of its hydrological environment but this does not effect its validity and should not be used as grounds for accepting *T. renata* as its name.

T. ligulata was collected only in the Sub-Tropical Zone and it is probable that the northern boundary of this region restricts its northerly movement (Text-fig. 34). The records made here appear to be the first for the species from the North Pacific Ocean; Rosa (1908*b*) reported it from 31° S., 80° W., in the South Pacific. All catches were made in nets hauled between 370 metres and the surface, and the largest number of specimens collected was six, at Trans-Pacific Stn. 120B, equivalent to fifteen per 1,000 m^3 of water, so that this species must only rarely become numerically abundant. Elsewhere in the world *T. ligulata* is known only from Tropical and Sub-Tropical waters.

T. apsteini was not collected at many stations but, nevertheless, these were all in the Sub-Tropical Zone (Text-fig. 35) and it probably never occurs further north than this region. Very rarely was more than one specimen collected, the most being four at Stn. 56 of the Northern Holiday Expedition, equivalent to five per 1,000 m^3 of water. All collections were made in the upper 300 metres. Rosa (1908*b*) first recorded *T. apsteini* from the North Pacific, off Mexico, and Izuka (1914) reported it off Misaki, Japan. Elsewhere in the world it is also known only from Tropical and Sub-Tropical waters.

T. nisseni occurred at stations scattered across the Sub-Tropical Zone (Text-fig. 35), but was never collected beyond its northern boundary which suggests that this acts as a barrier restricting its northerly movement. Dales (1955) recorded this species from deep water in Monterey Bay which was the first undoubted record from the North Pacific. On the Trans-Pacific Expedition *T. nisseni* was caught only in the top 370 metres of water; all of these catches except two were within North Pacific Central Water. At Stns. 7A and 7C it was collected in the California Current but it appears to inhabit this water only rarely for it was not recorded in Dales' (1957) extensive survey of the area.

Elsewhere in the world, in the southern hemisphere, *T. nisseni* is known only from Tropical and Sub-Tropical waters. In the North Atlantic, however, there are valid records from boreal waters (Wesenberg-Lund, 1950) and it was expected, therefore, that it would occur in the Sub-Arctic waters of the North Pacific; this matter is discussed further, below p. 469.

ALCIOPIDAE

Twelve species within this family are reported here. All were collected at numerous stations in the Sub-Tropical Zone; a few appeared also in the Transition

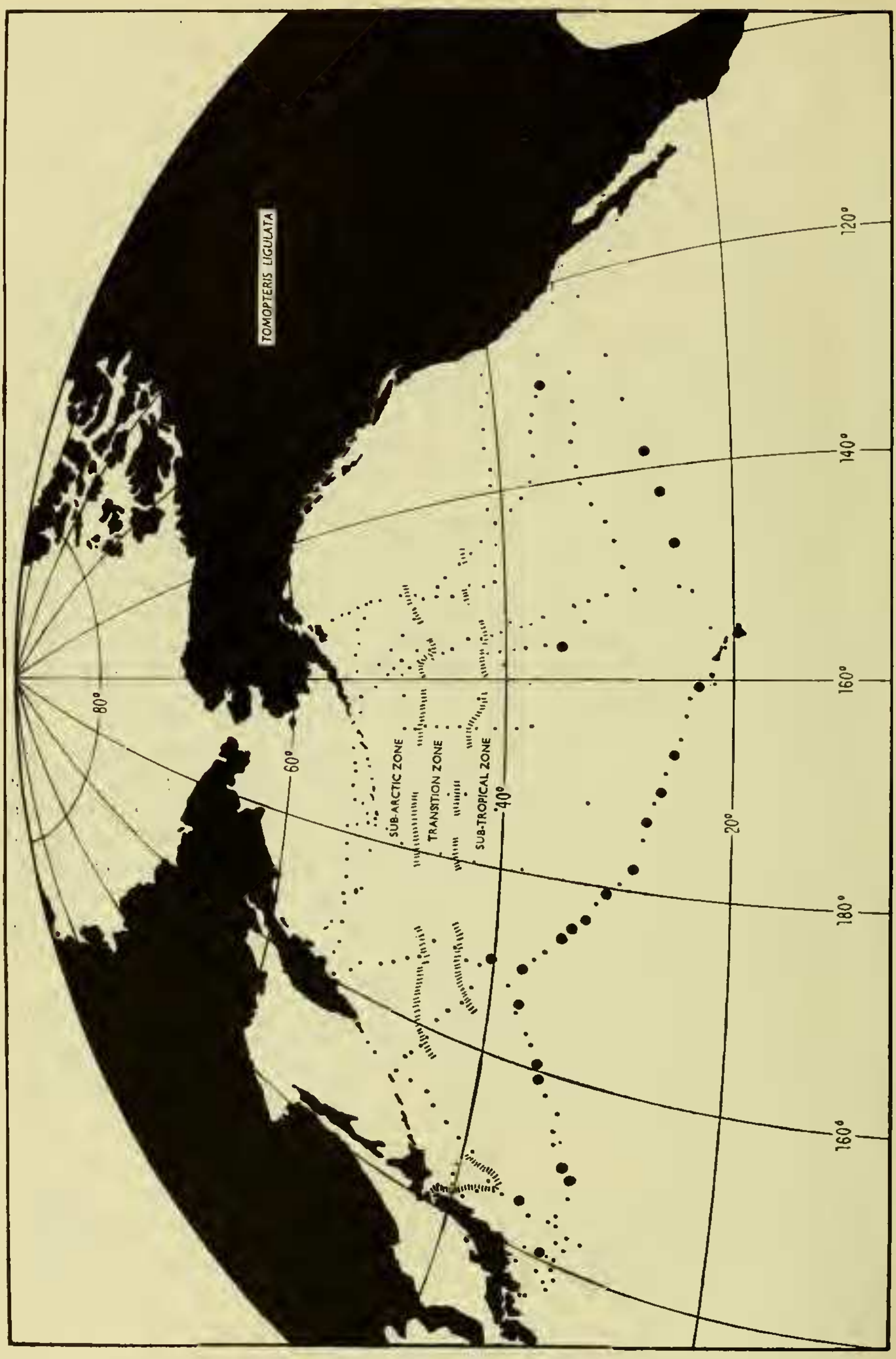

FIG. 34. Occurrence of *Tomopteris ligulata*.

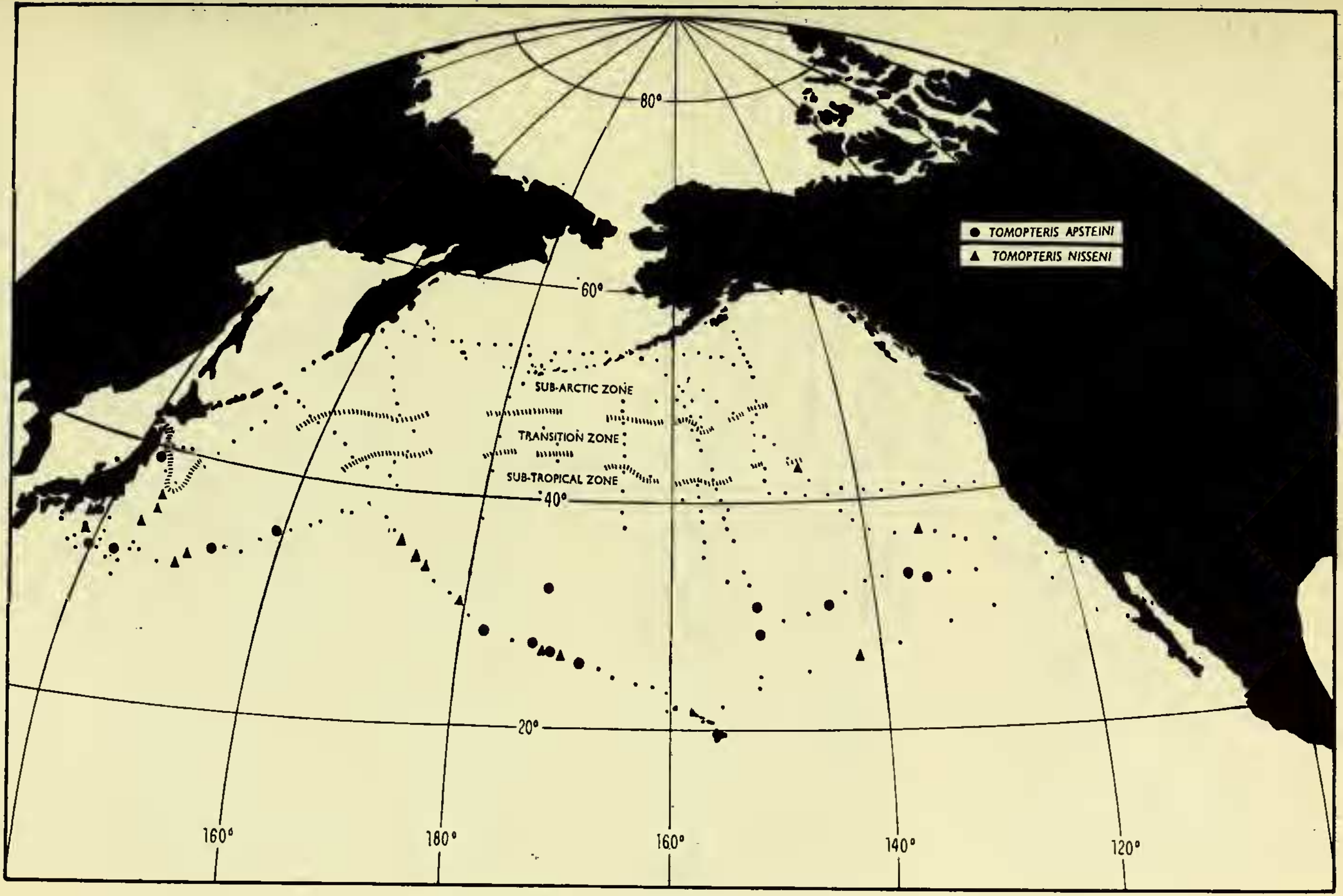

FIG. 35. Occurrence of *Tomopteris apsteini* and *T. nisseni*.

Zone but only one (*Rhynchonerella angelini*) was collected in abundance in the Sub-Arctic.

In Tables I and II of the Appendix the presence or absence of alciopid fragments (headless pieces) at each station has been indicated. This item is included because of the Zoogeographical importance of the family as a whole to which the presence or absence of these fragments lends significance. Thus many more genera and species of Alciopidae occur in the Sub-Tropical and Tropical Zones of the South Atlantic than in the waters of higher latitudes (Tebble, 1960), and this is shown below to apply also to the North Pacific. The recording of the presence of the fragments is additional proof of this. These were, for example, found at a large number of stations in the Sub-Tropical Zone (Appendix, Table I) but at very few in the Sub-Arctic (Table II); an indication that numerous species (up to twelve) can be found in the Sub-Tropical Zone and that only one permanently inhabits the Sub-Arctic.

NAIADES

Naiades cantrainii was collected at numerous stations all in the Sub-Tropical Zone (Text-fig. 36). It probably only rarely if ever occurs north of this region. Collected only by nets towed open to the surface, in the top 150 metres of water, *N. cantrainii* must here be considered a surface water species. The largest number of specimens present in any tow at which the amount of water filtered was measured, was two, at Stn. 104A, of the Trans-Pacific Expedition equivalent to five per 1,000 m^3 of water. The species was first reported from the North Pacific by Treadwell (1943 as *Alciopa distorta*), between California and Hawaii, and subsequently Dales (1957) found it in the California Current. Elsewhere in the world it is known only from Tropical and Sub-Tropical waters.

VANADIS

None of the five species of *Vanadis* reported here was collected in the Sub-Arctic Zone, and only *V. longissima* was collected in the Transition Zone (one record), so it is probable that the southern boundary of this latter region restricts their movement northwards. Elsewhere in the world all five species are known only from tropical and sub-tropical waters, except *V. longissima* which has also been reported from the sub-antarctic region of the South Atlantic (Tebble, 1960).

V. minuta was collected more often than any other alciopid, occurring regularly at stations across the breadth of the North Pacific, south of the Transition Zone (Text-fig. 37), and it clearly never penetrates north of the southern boundary of this region. It is evidently a surface water species for it was present in thirty-eight hauls towed open to the surface from 190 m., or less, but by only two nets closing at sub-surface depths (at Trans-Pacific Expedition Stns. 132B, 345–153 m. and 135B, 290–146 m.) and never appeared in nets closed at greater depths. The largest number collected was nine at Stn. 123A, equivalent to eighteen per 1,000 m^3 of water filtered, but normally the numbers were smaller than this and it may be presumed that *V. minuta* only rarely occurs in abundance. Treadwell's (1906) type

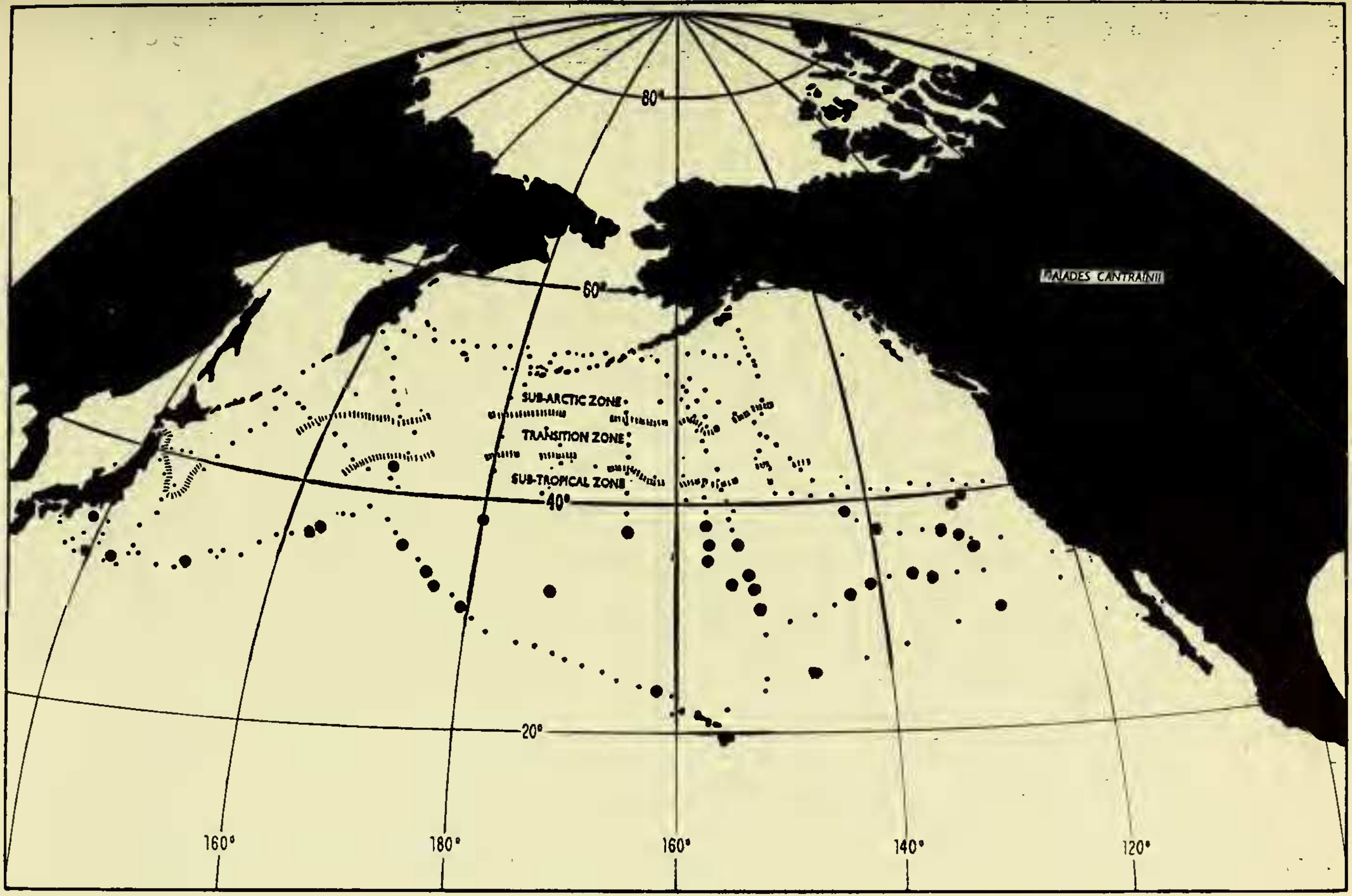

FIG. 36. Occurrence of *Naiades cantrainii*.

material came from the surface water off Hawaii, and Dales (1957) recorded it from the top 75 m. of water in the California Current.

Except for one record from Trans-Pacific Expedition Stn. 51A in the Transition Zone, all the records of *V. longissima* are from the Sub-Tropical Zone, where it occurred at numerous stations across the breadth of the North Pacific (Text-fig. 38). The largest number of specimens in any sample was eight at Trans-Pacific Expedition Stn. 104A, equivalent to twenty-one per 1,000 m^3 of water. Only one specimen was collected at Stn. 51A, and statistically such a record could be discarded, and the northerly limit to the distribution of *V. longissima* taken to be the northern boundary of the Sub-Tropical Zone, but in fact this one apparently anomalous record may cloak a potentially significant biological relationship. Thus, in the Systematic Account (above p. 393), it is noted that this one specimen had dark brown spots on the head and that specimens from other stations in the Sub-Tropical Zone, but close to the boundary with the Transition Zone, also exhibit this hitherto unreported character. It is possible therefore that a separate population of *V. longissima* inhabits the Transition Zone and immediately adjacent water to the south.

All records of *V. longissima* are from the nets towed open to the surface, and it may therefore be considered an inhabitant of the upper layers of the North Pacific Central water. It has previously been reported from the Sub-Tropical Zone of the North Pacific by Izuka (1914 as *V. grandis*), Treadwell (1943, as *Torrea fasciata*), Uschakov (1957*a*, as *V. pacifica*) and Dales (1957).

V. crystallina was collected only in the Sub-Tropical Zone, appearing at numerous stations (Text-fig. 39), and the southern boundary of the Transition Zone may be taken as the northern limit of its distribution in the North Pacific. It must penetrate into deep water there only rarely for all nets collecting it fished in the upper 400 m. The largest number collected was three, at Trans-Pacific Expedition Stn. 85A, equivalent to six per 1,000 m^3 of water. Dales (1957) reported *V. crystallina* from the California Current, this being the first record of the species from the North Pacific.

V. formosa did not occur at many stations, but these were scattered across the Sub-Tropical Zone (Text-fig. 40) and it is clear that it does not penetrate north of this region. Collected exclusively by nets towed open to the surface *V. formosa* must at the present state of our knowledge be considered a surface water species. Only rarely was there more than one specimen in a sample. The first record of *V. formosa* from the North Pacific was made by Treadwell (1943) from the Sub-Tropical Zone ; later Dales (1957) found it at sixty-seven stations in the California Current, in marked contrast to the comparatively few records made here. Because more than half of the latter are from east of 140° W., it may be that it is in this area of the North Pacific that the main concentrations of this species are to be found.

Known exclusively from the North Pacific Ocean *V. tagensis* was present in only seventeen of the 416 samples examined. Twelve of these are from nets closed at depth (between 680–130 m.) and the remainder from nets towed through a considerable distance open to the surface so that the species can be considered a deeper water form. The few records made may be explained by the smaller number of

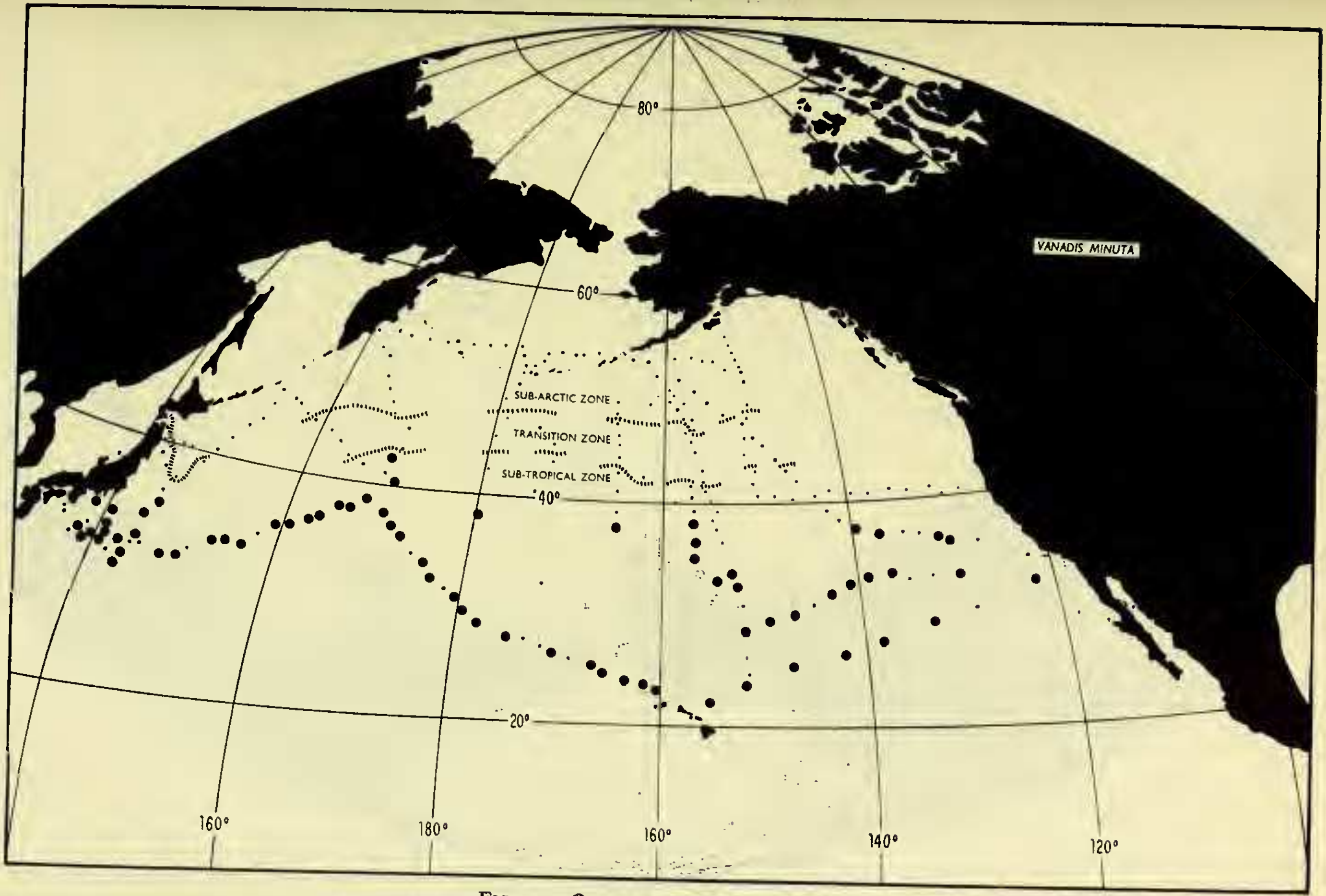

FIG. 37. Occurrence of *Vanadis minuta*.

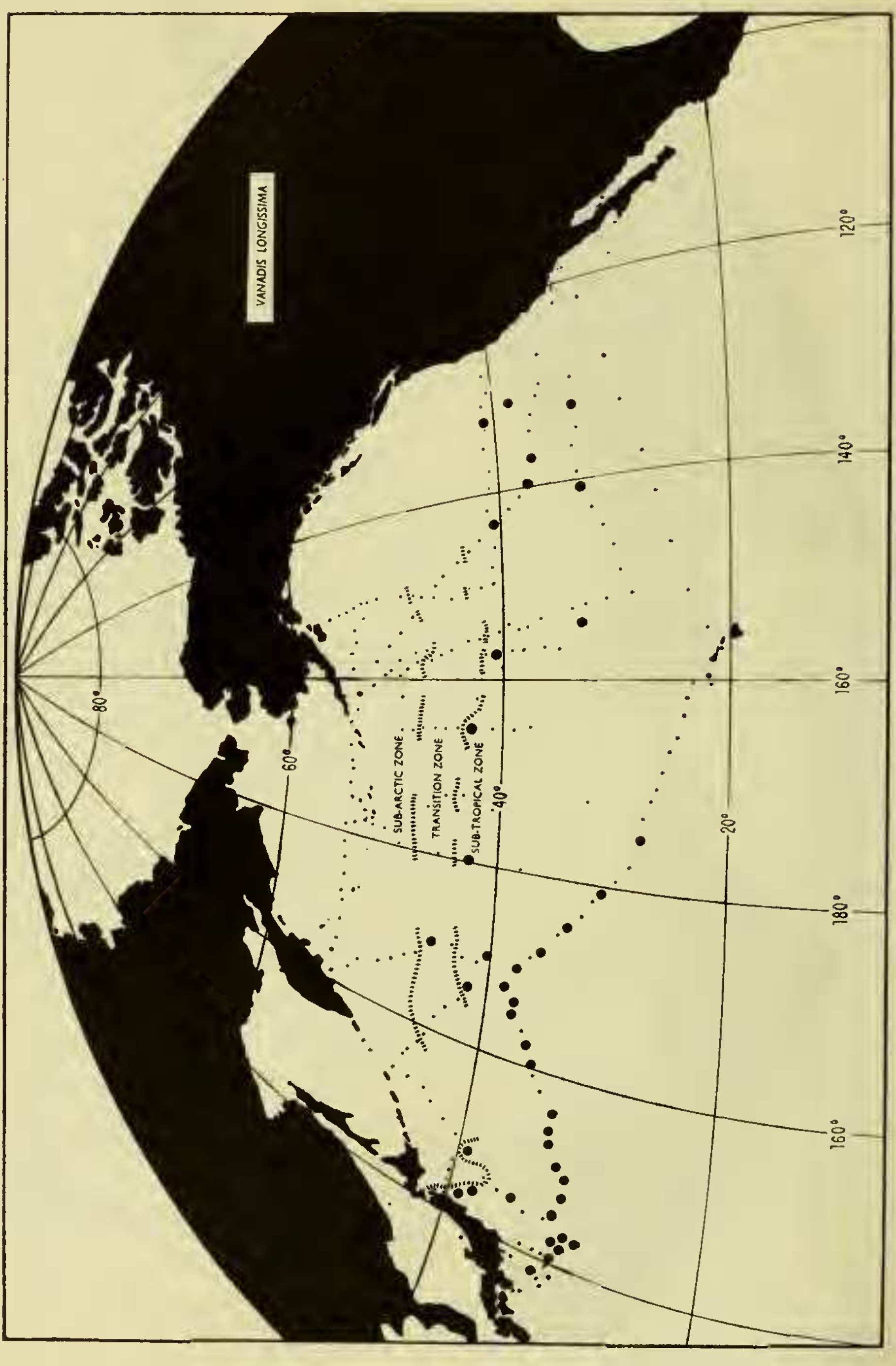

FIG. 38. Occurrence of *Vanadis longissima*.

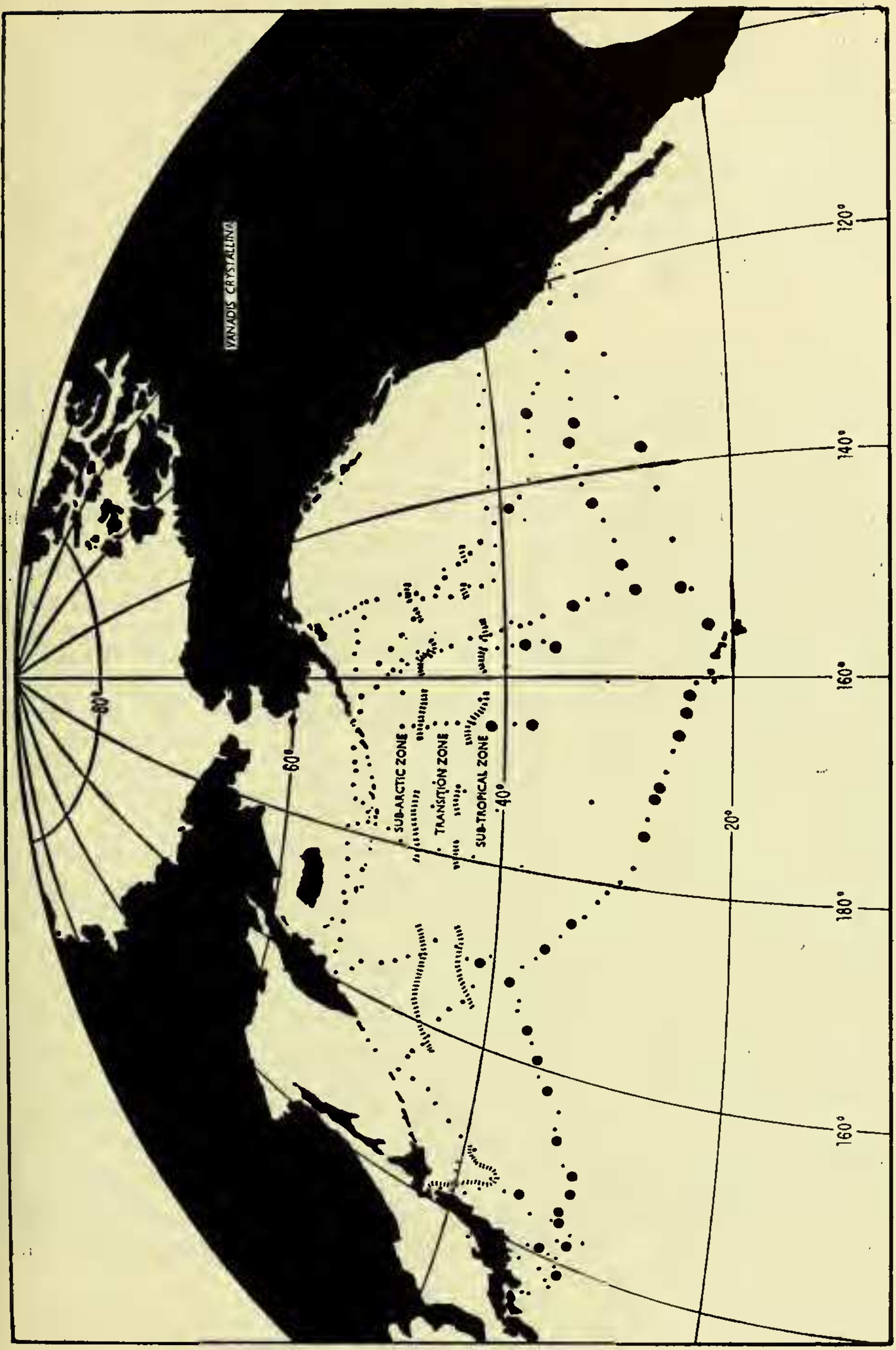

FIG. 39. Occurrence of *Vanadis crystallina*.

nets which were closed at depth (Table I). None of the catches of *V. tagensis* was north of the Sub-Tropical Zone (Text-fig. 40) and it is possible that the northern boundary of this region restricts its movement into the higher latitudes. At two stations two specimens were caught but at the others only one was collected. The original records of *V. tagensis* were made from Monterey Bay, between 500–1,000 m. (Dales, 1955) and it is apparent that the late discovery of this species, and the comparatively limited area from which it is known, is due to its deep water habitat, for few expeditions can sample the deep layers as exhaustively as they do the surface waters. A much wider range of distribution for this species may become apparent when more deep water collections have been made.

RHYNCHONERELLA

Four species of this genus were present in the collections. *R. petersii* and *R. mobii* in the Sub-Tropical and Transition Zones, *R. gracilis* mainly in these two but also at a few stations in the Sub-Arctic and *R. angelini* in some abundance in all three.

R. petersii was found at numerous stations in the Sub-Tropical Zone and occasionally penetrates into the Transition Zone (Text-fig. 41), the northern boundary of the latter region probably restricting its movement into higher latitudes. At most stations only one specimen was collected but four were in the sample from Stn. 11A of the Trans-Pacific Expedition. This is equivalent to five per 1,000 m^3 of water. Clearly the species must only rarely occur in abundance. Most records are from the top 300 m. of water, but at Stn. 12F a net towed between 850–680 m. collected one specimen. This record must be treated as an anomaly until extensive collections at depth prove otherwise. The only previous record of *R. petersii* from the North Pacific was made by Uschakov (1957*a*, as *Callizona setosa*) from the Sub-Tropical Zone in the Western Pacific. *R. petersii* is not well known from other oceans in the world but has not been reported outside Tropical and Sub-Tropical waters.

R. mobii was found at comparatively few stations. These, however, were all within the Sub-Tropical Zone (Text-fig. 42) indicating that it rarely moves further north than this region. There was never more than one specimen of this species in a sample. It was collected in nets towed open in the top 400 m. of water and in closing nets hauled between 370–140 m. Evidently *R. mobii* is principally an inhabitant of the upper waters; Dales (1957) first recorded it in the North Pacific from the surface waters of the California Current. Elsewhere in the world *R. mobii* is known from few records but these are all from Tropical and Sub-Tropical waters.

R. gracilis was present in numerous samples most of which came from the Sub-Tropical Zone (Text-fig. 43). It also appeared, however, in the Transition Zone and at two stations in the Sub-Arctic Zone. If, as is probable, *R. gracilis* has its northern limit of distribution at the southern boundary of the Sub-Arctic Zone the specimens collected beyond this boundary could be explained as accidental survivors outside their hydrological limits. This may be true of the specimen from Trans-Pacific Expedition Stn. 48D but is almost certainly not applicable to that

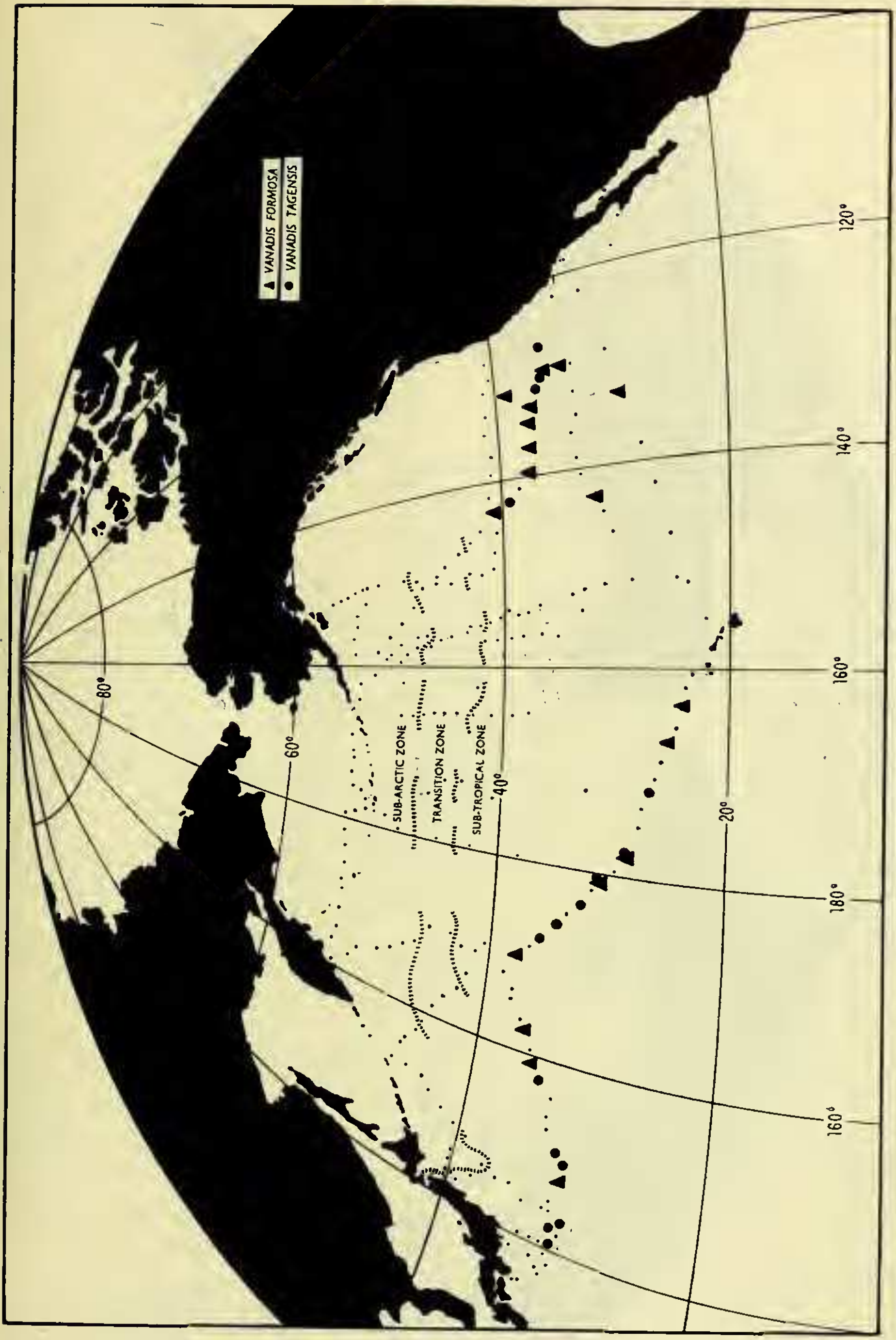

Fig. 40. Occurrence of *Vanadis formosa* and *V. tagensis.*

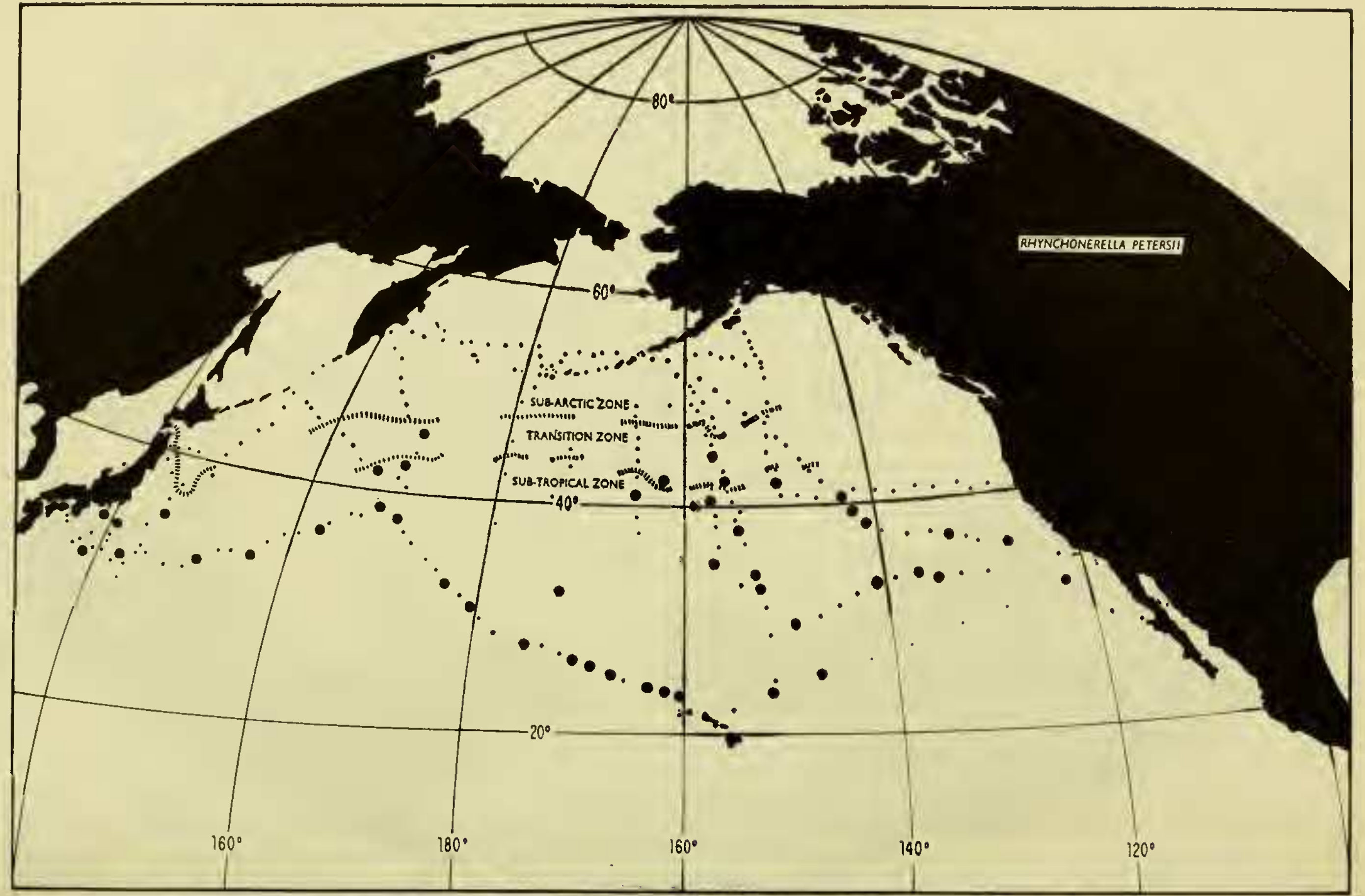

FIG. 41. Occurrence of *Rhynchonerella petersii.*

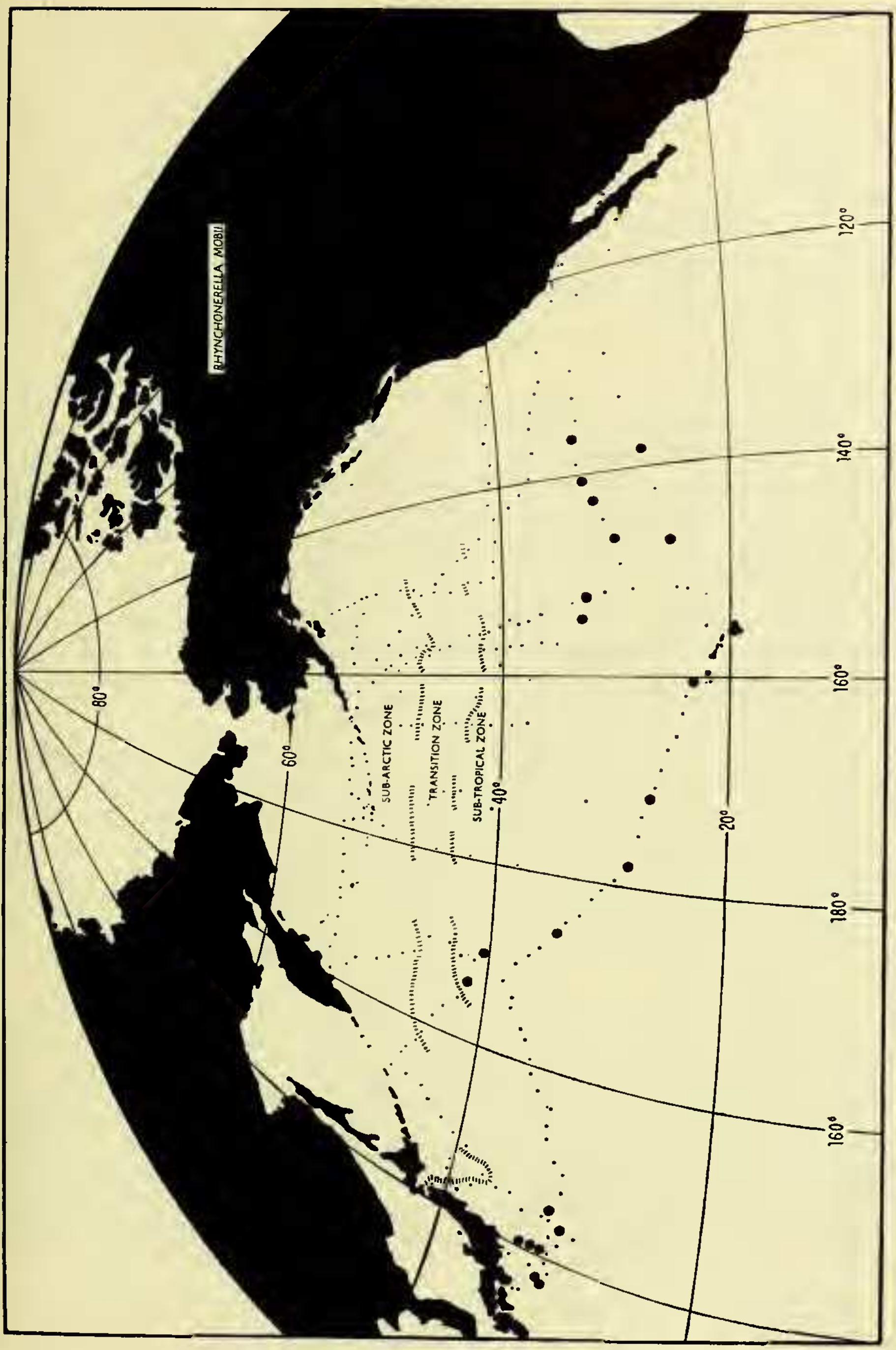

FIG. 42. Occurrence of *Rhynchonerella mobii.*

from Northern Holiday Exp., Stn. 26, which is much further north of the boundary line, and within the region of the Alaskan gyral. Further collections from the North East Pacific will have to be examined before it can be established that *R. gracilis* does not inhabit this region as an occasional, possibly seasonal migrant.

R. gracilis was collected mainly by nets which were towed open to the surface; the majority of these fished only in the top 400 m. of water within which layer the species appears to concentrate. In most samples only one specimen was collected but six were caught at Stn. 110A, of the Trans-Pacific Expedition equivalent to twelve per 1,000 m^3 of water.

R. gracilis was first reported from the North Pacific, off Misaki, Japan, by Izuka (1914 as *Callizona japonica*) and subsequently by Uschakov (1957*a* as *C. nasuta*) from between 35–40° N., about 151° E., and Berkeley & Berkeley (1960) with one record as far north as 54° 30′ N., about 152° W., and two others in the Transition Zone.

R. angelini was found in all three hydrological zones (Text-fig. 44). This was to be expected if its pattern of distribution in the Atlantic Ocean, as suggested by Tebble (1960), was to be repeated in the Pacific. Thus, although restricted in its movements southwards, in the southern hemisphere by the Sub-Tropical Convergence, there is no comparable restriction in the northern hemisphere. In the latter there are no endemic pelagic polychaetes in higher latitudes and some of the species there may be taken to represent Antarctic endemic elements in boreal waters, *R. angelini* for instance representing the endemic antarctic *R. bongraini*; the evidence found in the present work suggests that this is now applicable to the North Pacific in the case of these species of *Rhynchonerella*.

Throughout all three hydrological zones *R. angelini* was caught in nets towed open in the top 200–300 m. of water and in some nets closing between 500 and 121 m. Only on very few occasions were more than one specimen collected.

R. angelini was first recorded from the North Pacific by Moore (1908 as *Callizona angelini*) in the stomachs of salmon caught off the coast of Alaska, and was subsequently reported under the same name by Berkeley (1930), from the east coast of Vancouver, by Berkeley & Berkeley (1957, 1958 and 1960), from the Sub-Arctic Zone, and the Sub-Tropical Zone; Treadwell (1943 as *Rhynchonerella pycnocera*) reported it from the Sub-Tropical Zone and Dales (1955 and 1957) from Monterey Bay and the California Current.

PLOTOHELMIS

P. tenuis was found at numerous stations across the Sub-Tropical Zone and in a few samples in the Transition and Sub-Arctic Zones (Text-fig. 45). Most of the records from the latter region were near its southern boundary and probably indicate minor intrusions of warmer water. Nevertheless, in suggesting that the southern boundary of the Sub-Arctic Zone restricts the northerly movement of *P. tenuis* in the North Pacific, I draw attention to these records, for they may indicate a seasonal migration outside the normal hydrological limits of the species. *P. tenuis* was found in open and closing nets at all depths from 850 m. to the surface, occurring

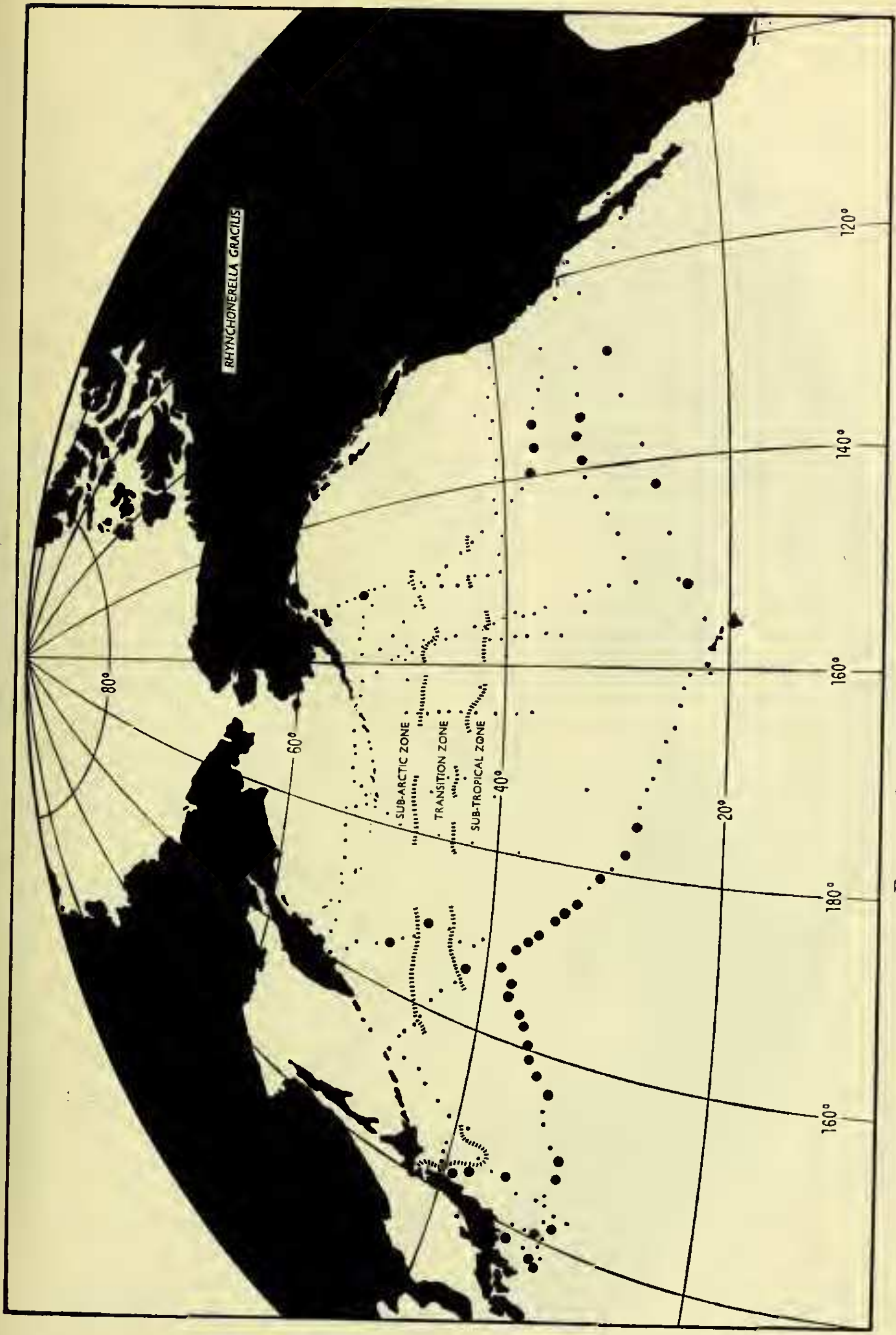

FIG. 43. Occurrence of *Rhynchonerella gracilis*.

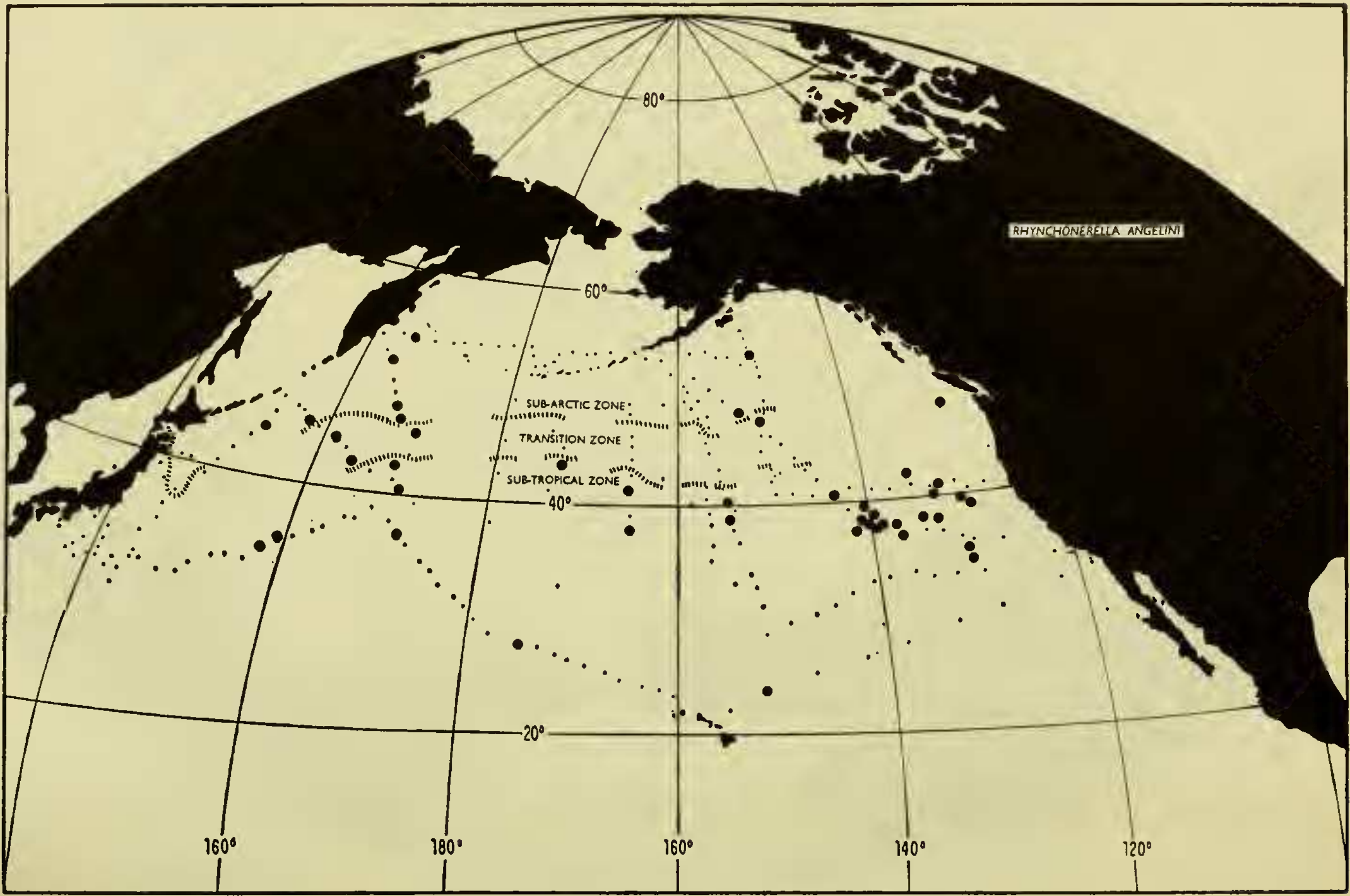

Fig. 44. Occurrence of *Rhynchonerella angelini*.

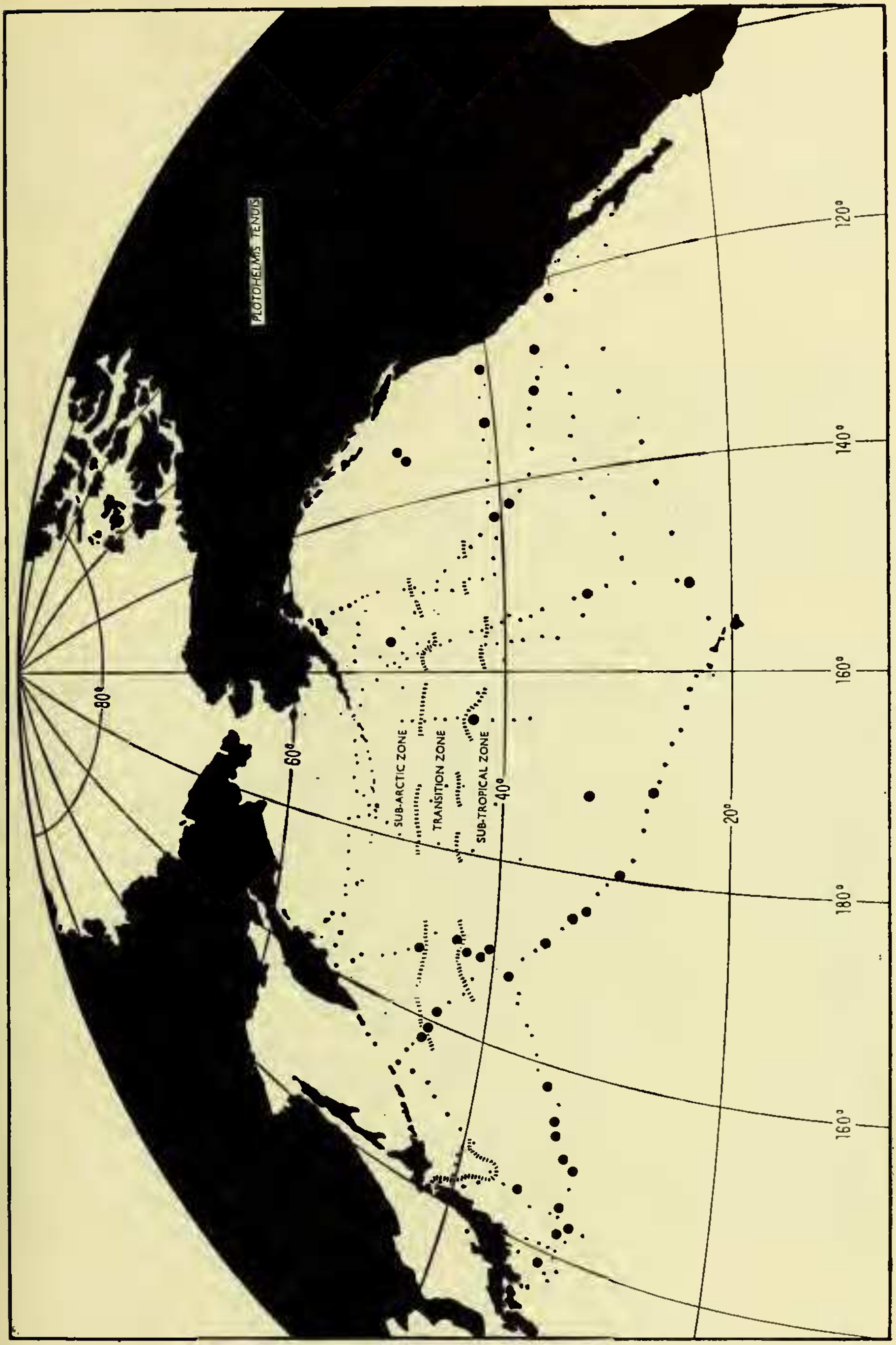

FIG. 45. Occurrence of *Plotohelmis tenuis*.

more frequently in the upper layers where most nets fished. Only on few occasions were more than one specimen collected but an exceptionally large catch was made at Northern Holiday Station 2, sixty-nine specimens, equivalent to 110 per 1,000 m^3 of water, being caught. Izuka (1914) was the first to describe this species from the North Pacific as *Rhynchonerella fulgens* from off Misaki, Japan, and Dales reported it from Monterey Bay (1955) and in the California Current (1957). Elsewhere in the world *P. tenuis* is known from comparatively few records and the limits to its distribution cannot be precisely fixed, but it is probably a Sub-Tropical and Tropical species.

KROHNIA

Krohnia lepidota was found only in the Sub-Tropical Zone (Text-fig. 46) and it is doubtful if it ever occurs further north than this region. It was collected entirely by nets fishing in the top 370 m. of water and at most stations only one specimen was found, but four were present at Trans-Pacific Expedition Stn. 97A, equivalent to five per 1,000 m^3 of water.

Chamberlin (1919) first recorded *K. lepidota* from the North Pacific as *Rhynchonerella cincinnata* off the SW. coast of Mexico and Treadwell (1943) reported it as *Callizona pigmenta* from 12° 40′ N., 137° 32′ W. Elsewhere in the world *K. lepidota* is known only from Sub-Tropical and Tropical waters.

TYPHLOSCOLECIDAE

Six species of this family were present in the collections. Of these the cosmopolitan *Typhloscolex mülleri* was very common everywhere, and *Sagitella kowalewskii* and *Travisiopsis lobifera* were present in abundance in the Sub-Tropical Zone ; however, the other three species *Travisiopsis levenseni*, *lanceolata* and *dubia* were collected only rarely and it is not possible to be conclusive about their distributional limits.

Typhloscolex mülleri was found in all three hydrological zones occurring in greatest abundance in the Sub-Arctic (Text-fig. 47). It was collected at all explored depths, in both open and closing nets. These records confirm the known distribution of this species in the North Pacific where it has been reported from the Sub-Tropical and Sub-Arctic by Treadwell (1943) and Uschakov (1957*a*) ; the Sub-Arctic by Uschakov (1952, 1955) and Berkeley & Berkeley (1948, 1957, and 1960) ; the Transition Zone by Berkeley & Berkeley (1960) and the California Current by Dales (1957). In addition Uschakov (1957*b*) records it from high Arctic waters in approximately 80° N., near 180°. It has been noted in the Systematic Account (pp. 408–409) that in the North Pacific an ecotype of *T. mülleri* inhabits the Sub-Arctic Zone.

Sagitella kowalewskii was present at a large number of the stations made in the Sub-Tropical Zone ; indeed the persistence of its occurrence there was a feature of the collections (Text-fig. 48). It is probable therefore that the southern boundary of the Sub-Arctic Zone marks the northern limit of its distribution although one specimen was found just north of this boundary. Generally no more than ten

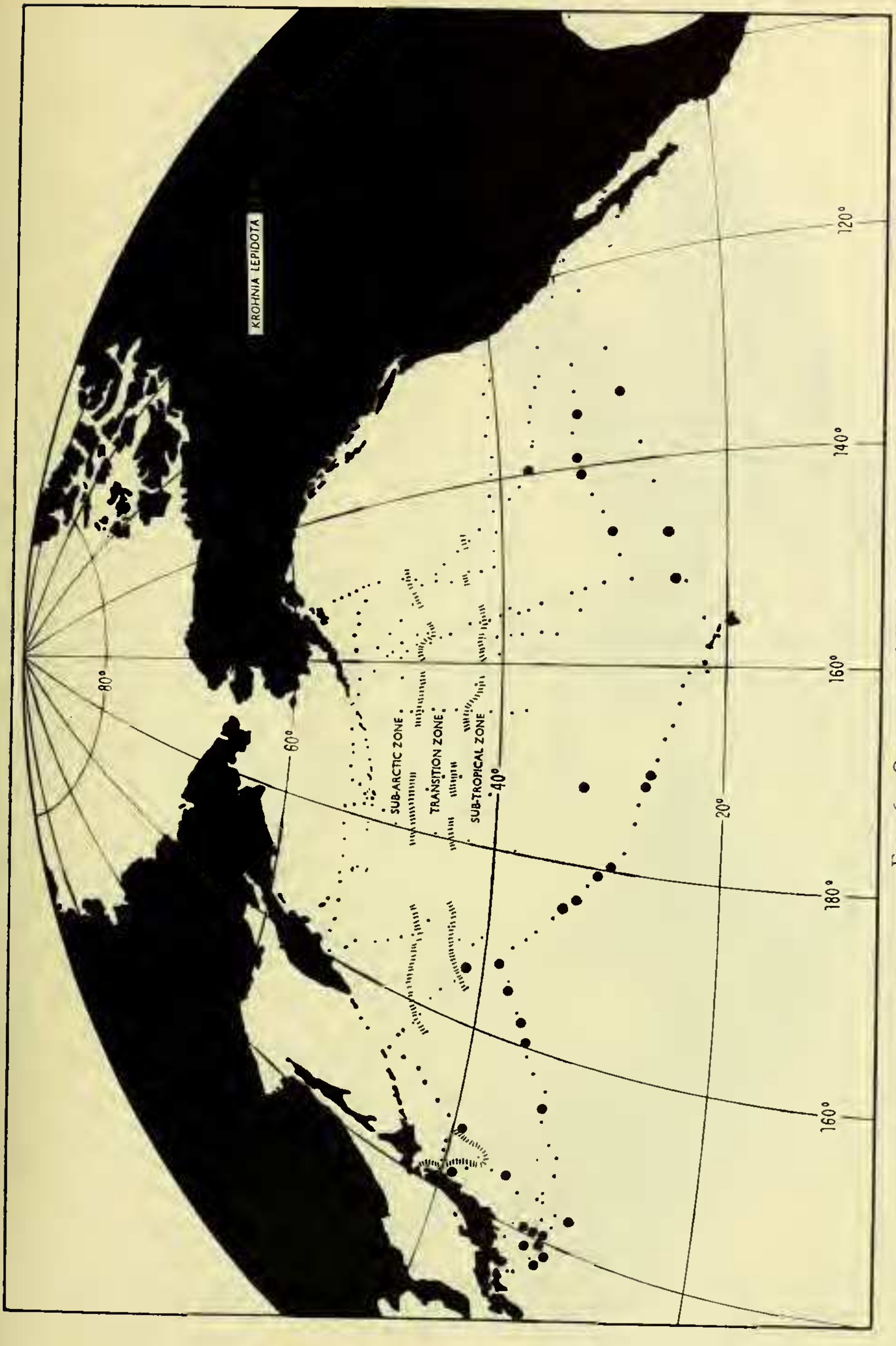

Fig. 46. Occurrence of *Krohnia lepidota.*

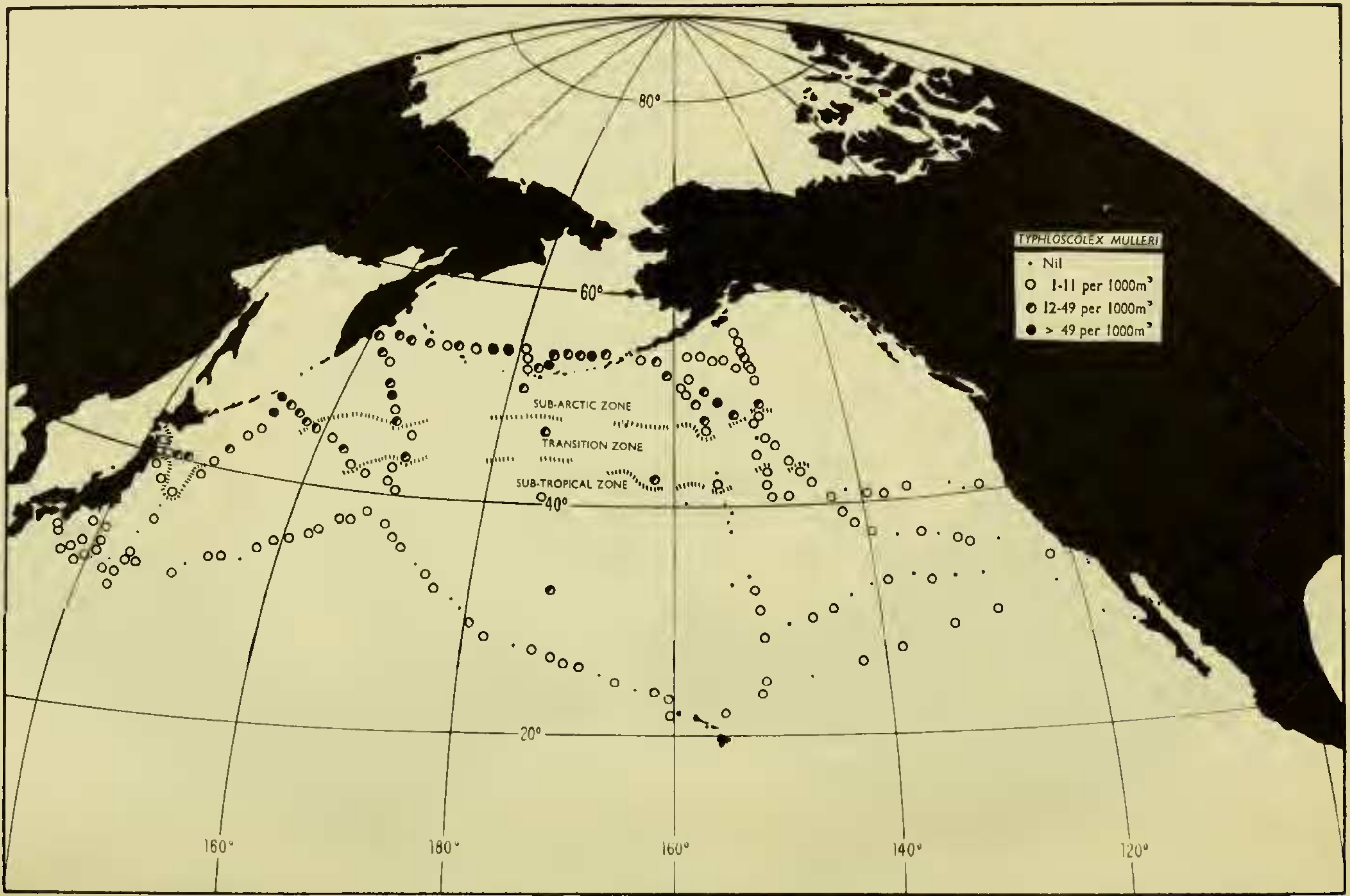

FIG. 47. Occurrence of *Typhloscolex mulleri*.

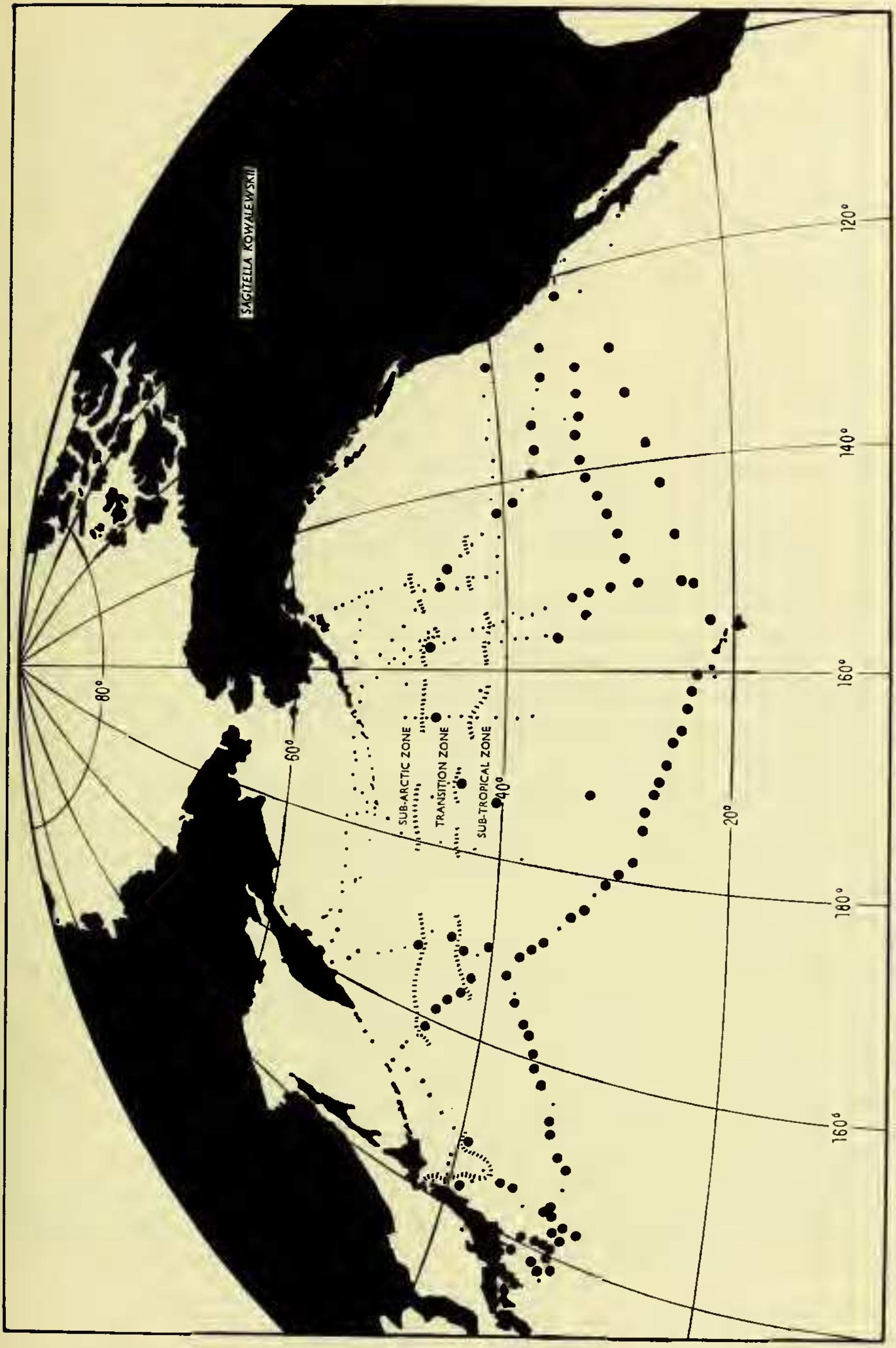

FIG. 48. Occurrence of *Sagitella kowalewskii*.

specimens of *S. kowalewskii* were present in a sample with exceptionally fourteen at Stn. 86A of the Trans-Pacific Expedition, equivalent to thirty per 1,000 m³ of water filtered. It was found at all explored depths in both open and closing nets, and evidently is capable of a wide distribution in deep and surface water circulations.

Berkeley (1930) was the first to record *S. kowalewskii* from the North Pacific, finding it off Vancouver Island; subsequently Okuda (1937, 1938) reported it from sub-tropical water off Japan and Treadwell (1943 as *Plotobia paucichaeta*) and Uschakov (1957*a*) recorded it from the Sub-Tropical and Transition Zones, and Dales (1957) found it in the California Current; Uschakov (1957*a*), however, also records it off Kamchatka in about 52° N., well within the Sub-Arctic Zone. I hesitate to accept this record in the face of no supporting evidence from other expeditions, notwithstanding Berkeley & Berkeley's (1960) record from 50° N., in the north-east Pacific which I consider an area to which the species could migrate within the Alaskan gyral (Text-fig. 2).

Travisiopsis lobifera was collected at numerous stations across the Sub-Tropical Zone and appeared also in the Transition Zone where the northern boundary probably restricts its movement northwards (Text-fig. 49). On few occasions were more then ten specimens collected but an exceptional catch was made at Trans-Pacific Expedition Stn. 99A, where fifty-four specimens were caught, equivalent to forty-two per 1,000 m³ of water. Most nets collecting this species fished in the upper 330 metres but it was also caught between 680 and 130 metres suggesting that it inhabits a considerable depth of water. Although persistent in its occurrence in the western and eastern North Pacific *T. lobifera* was only rarely found south of 40° N., between 140° W., and 180°.

The first record of *T. lobifera* from the North Pacific was made by Dales (1955) from Monterey Bay, who in 1957 also reported it from the California Current. Uschakov (1957*a*) reported it from the northern region of the Transition Zone in the western North Pacific and Berkeley & Berkeley (1957 and 1960) from the same zone in the eastern North Pacific. This last record includes one from 51° 21′ N., 149° 21′ W., the farthest north the species has ever been recorded, and with that made by Uschakov (1957*a*) is additional evidence for the suggestions made above that it is the northern boundary of the Transition Zone that marks the northern limit of its distribution.

Travisiopsis levinseni is known from the North Pacific only through the records made by Dales (1955) from deep water in Monterey Bay and the three made here from the Trans-Pacific Expedition (Text-fig. 50). The latter are from nets which could have collected it in deep water but clearly little can be said about its distribution until more records are available. The few records made may be due to lack of extensive sampling of the deeper layers. In the Atlantic Ocean *T. levinseni* is known from all extremes of hydrological conditions (Støp-Bowitz, 1948; Tebble, 1960) and is generally considered a cosmopolitan species.

Travisiopsis lanceolata was collected at only nine stations, these being mainly in the Sub-Tropical Zone but two catches were made in the Transition Zone and one in the Sub-Arctic (Text-fig. 50). Most of these were by nets closing at depth but more extensive collecting in the deeper water will be required in order to define the

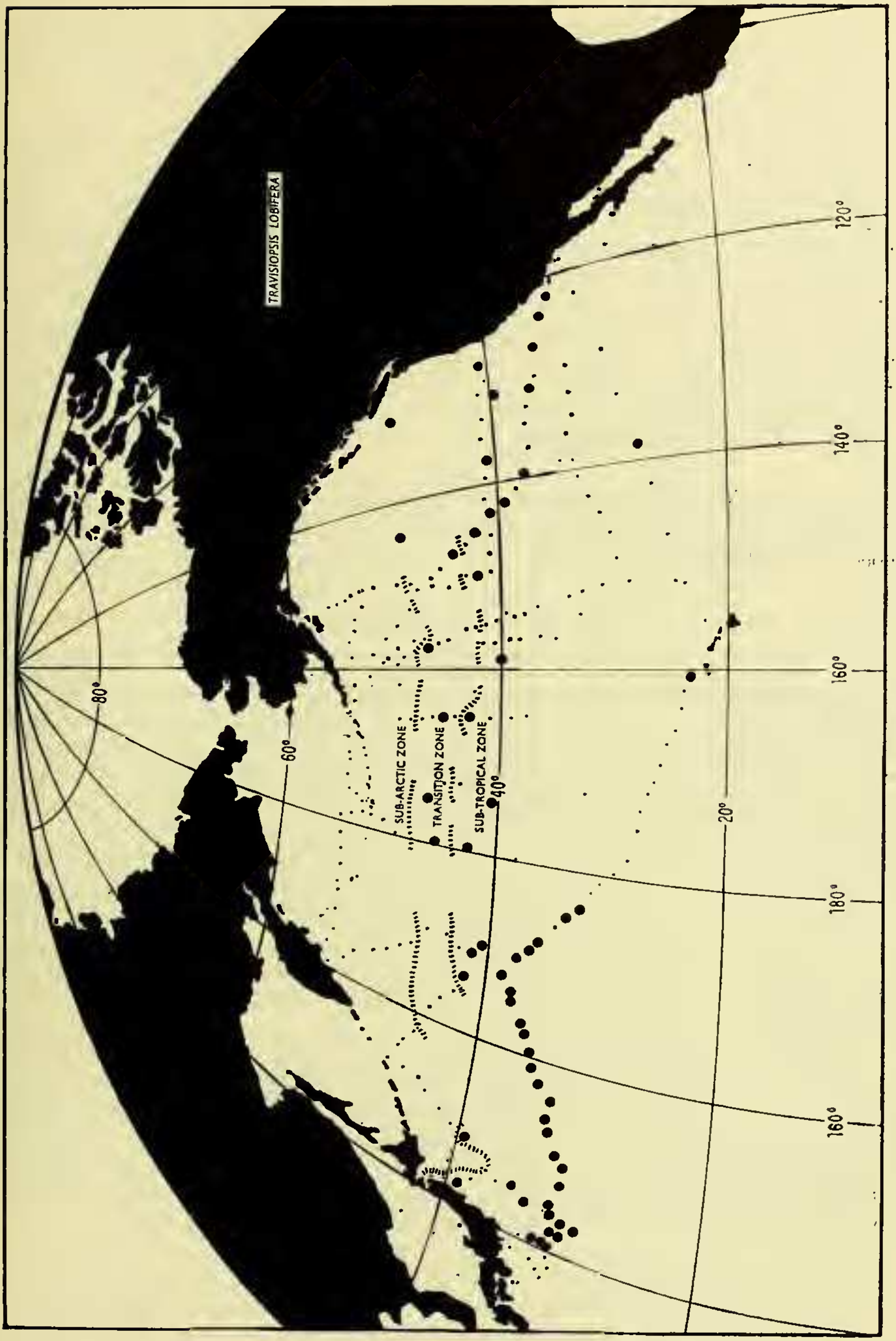

FIG. 49. Occurrence of *Travisiopsis lobifera*.

limits of its distribution. *T. lanceolata* was first recorded from the North Pacific by Treadwell (1943 as *Plotobia simplex*), from five records in the Sub-Arctic Zone and two in the Sub-Tropical. All these records suggest that this species inhabits both warm and cold water regions of the North Pacific as it does in the North Atlantic (Støp-Bowitz, 1948).

Travisiopsis dubia was collected at only eight stations, all in the Sub-Tropical Zone (Text-fig. 50) and all in nets towed open to the surface. These are the first records of this species from the North Pacific and only Dales (1960) has previously reported it from the South Pacific. Dales' records were made possible through the collections of the Trans-Pacific Expedition, which I was able to show him were identical with material he had from the South China Sea. Otherwise known only through its original discovery in the Atlantic Ocean by Støp-Bowitz (1948) from 39° 30′ N., 49° 42′ W., and 48° 24′ N., 36° 53′ W., *T. dubia* is not known from sufficient records for its distribution to be comprehensively analysed. Moreover, because it is very like *Sagitella kowalewskii* (see above, p. 415), it may have been overlooked among previous collections of this species and these will have to be re-examined before the situation is clarified.

PHYLLODOCIDAE (LOPADORHYNCHINAE AND IOSPILINAE)

Eight species of this family are reported here, showing a diversity of generic and specific distribution not met with in any other family of pelagic polychaetes.

LOPADORHYNCHINAE

PELAGOBIA

Pelagobia longicirrata was collected in all three hydrological zones (Text-fig. 51). This was as expected for in the Atlantic it has been reported from all extremes of hydrological conditions (Støp-Bowitz, 1948 ; Tebble, 1960) and is generally accepted as a cosmopolitan species. It occurred in its greatest abundance in the Sub-Arctic Zone with sixty-five specimens at Stn. 40C of the Trans-Pacific Expedition, equivalent to one hundred and ninety-five per 1,000 m^3 of water. This was the largest catch made at any station. There were numerous stations in this zone however where no more than one to five specimens of *P. longicirrata* were collected per 1,000 m^3, as was common in the Sub-Tropical Zone. In all hydrological zones it appeared at all explored depths but had its greatest abundance in the nets closed between 700 and 300 metres. Clearly this species has a very wide depth range in the North Pacific, similar to that found in the Sub-Antarctic and Antarctic Zones of the South Atlantic by Tebble (1960).

The first record of *P. longicirrata* from the North Pacific was made by Chamberlin (1919, as *P. vigueri*) from the Tropical Zone, subsequently Okuda (1937, 1938), Treadwell (1943, as *P. vigueri*), Dales (1955, 1957), Uschakov (1957*b*), and Berkeley & Berkeley (1960) reported it from the Sub-Tropical Zone and Treadwell (1943), Uschakov (1952 as *P. vigueri* ; 1957*a*) and Berkeley & Berkeley (1960) found it in the Transition and Sub-Arctic Zones. It was also reported from north of 76° N., by Uschakov (1957*b*), the most northerly record for the species.

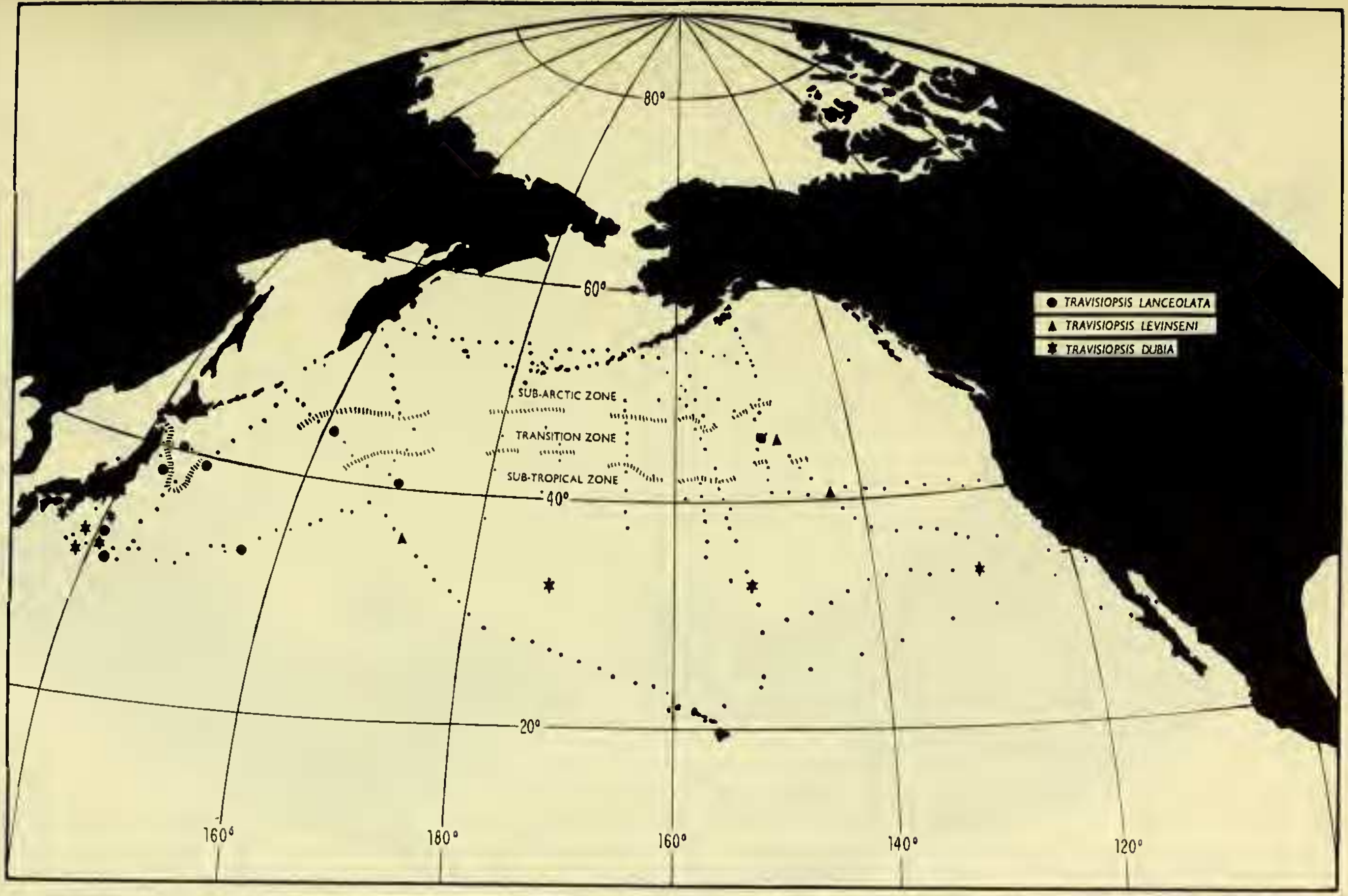

FIG. 50. Occurrence of *Travisiopsis lanceolata*, *T. levinseni* and *T. dubia*.

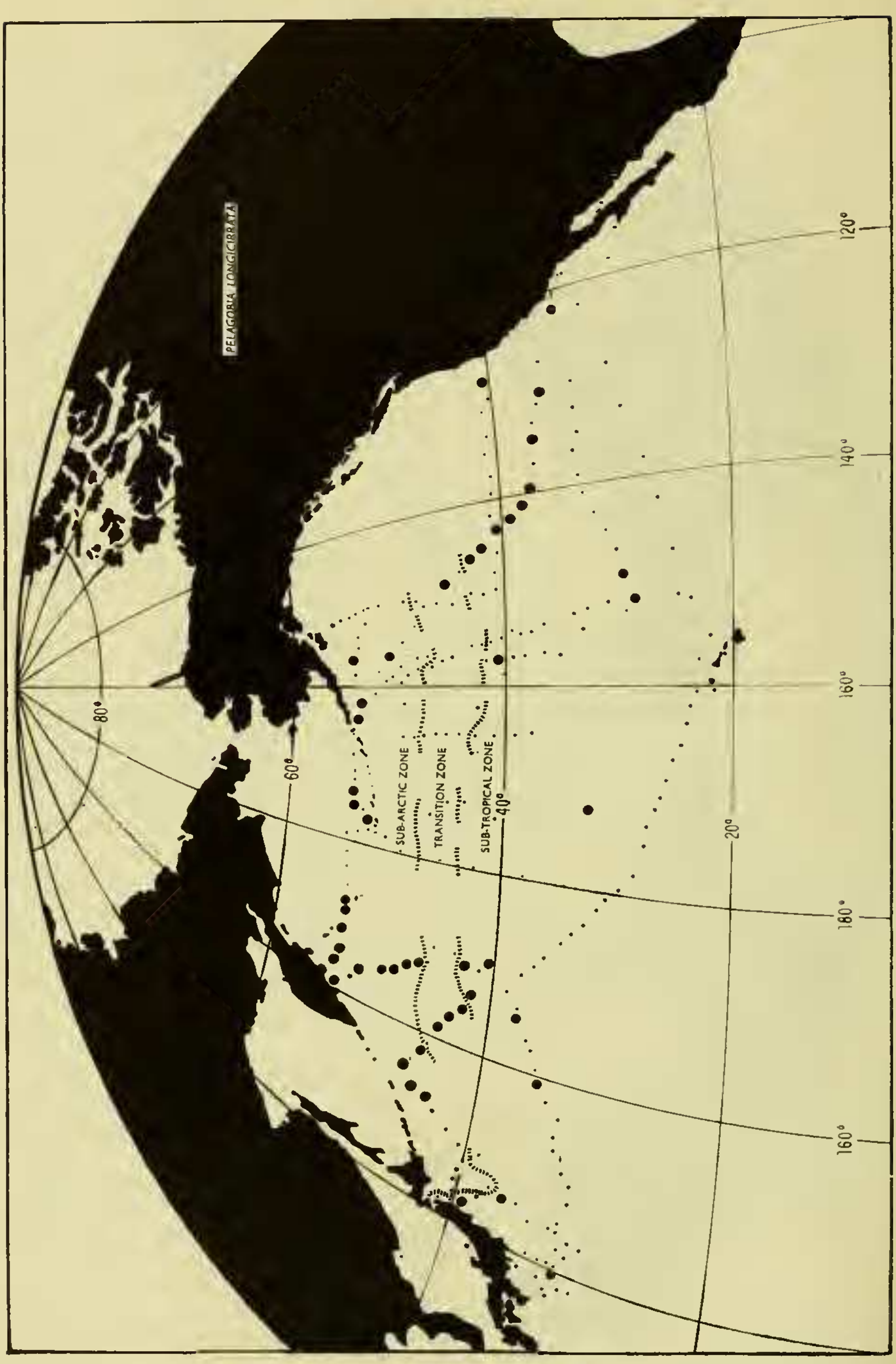

FIG. 51. Occurrence of *Pelagobia longicirrata*.

LOPADORHYNCHUS

Three species of this genus are reported here, *L. krohnii*, *L. uncinatus* and *L. brevis*. All three were collected only within the Sub-Tropical Zone, and elsewhere in the world are known only from Tropical and Sub-Tropical waters.

Lopadorhynchus krohnii was present at numerous stations (Text-fig. 52) and clearly never penetrates north of the Sub-Tropical Zone. It was rare for more then one or two specimens of this species to be in any sample but six were caught at Stn. 61 of the Northern Holiday Expedition, equivalent to eight per 1,000 m^3 of water. It was collected exclusively in nets towed in the upper 370 metres, and must be essentially a surface water species. This appears to be only the second record of *L. krohnii* from the North Pacific, Dales (1957) having first recorded it from the California Current.

L. uncinatus was collected at only eleven stations (Text-fig. 53) but these ranged across the ocean and were also close to the northern boundary of the Sub-Tropical Zone which almost certainly restricts its movement northwards. Although not caught very often, on only one occasion was more than one specimen collected, *L. uncinatus* was present in nets towed a little deeper than those which caught *L. krohnii*, and it may inhabit a greater depth range. *L. uncinatus* was first recorded from the North Pacific by Treadwell (1943 as *L. varius*) at seven stations made by the *Carnegie* in the Tropical and Sub-Tropical Zones between San Francisco and the Marshall Is.: Dales (1955 and 1957) subsequently reported it from Monterey Bay and the California Current and Berkeley & Berkeley (1958) found it at 20° 00′ N., 110° 35′ W. Berkeley & Berkeley (1960) also report a specimen—" 1 mm. long, probably larval ", from 54° 30′ N., 152° 00′ W., which they call *L. uncinatus*; this is, I think, a most unusual record, and will have to be confirmed.

L. brevis was caught more often than *L. uncinatus*, though again across the breadth of the North Pacific and on occasion close to the northern boundary of the Sub-Tropical Zone (Text-fig. 53). This probably marks the limit of its northerly movement. Never more than one specimen was collected. All catches were in nets towed open in the top 290 metres of water, indicating that it is probably a surface water species. The first record of *L. brevis* from the North Pacific was made by Chamberlin (1919 as *L. parvum*) off the coast of Mexico (15° 58′ N., 98° 13′ W.) and subsequently Dales (1957) reported it from the California Current and Berkeley & Berkeley (1958) from 3° 03′ N., 101° 35′ W., and 10° 52′ N., 88° 02′ W.

MAUPASIA

M. caeca was found in all three hydrological zones (Text-fig. 54). This was expected because in the South Atlantic Ocean it is already known from warm and cold water regions (Tebble, 1960). On only two occasions were more than one specimen collected, and it appeared only in nets towed in the upper 525 metres of water. A number of these were closed in the deeper part of the layer indicating that *M. caeca* inhabits a considerable depth range.

M. caeca was first recorded from the North Pacific by Uschakov (1957*a*) from the

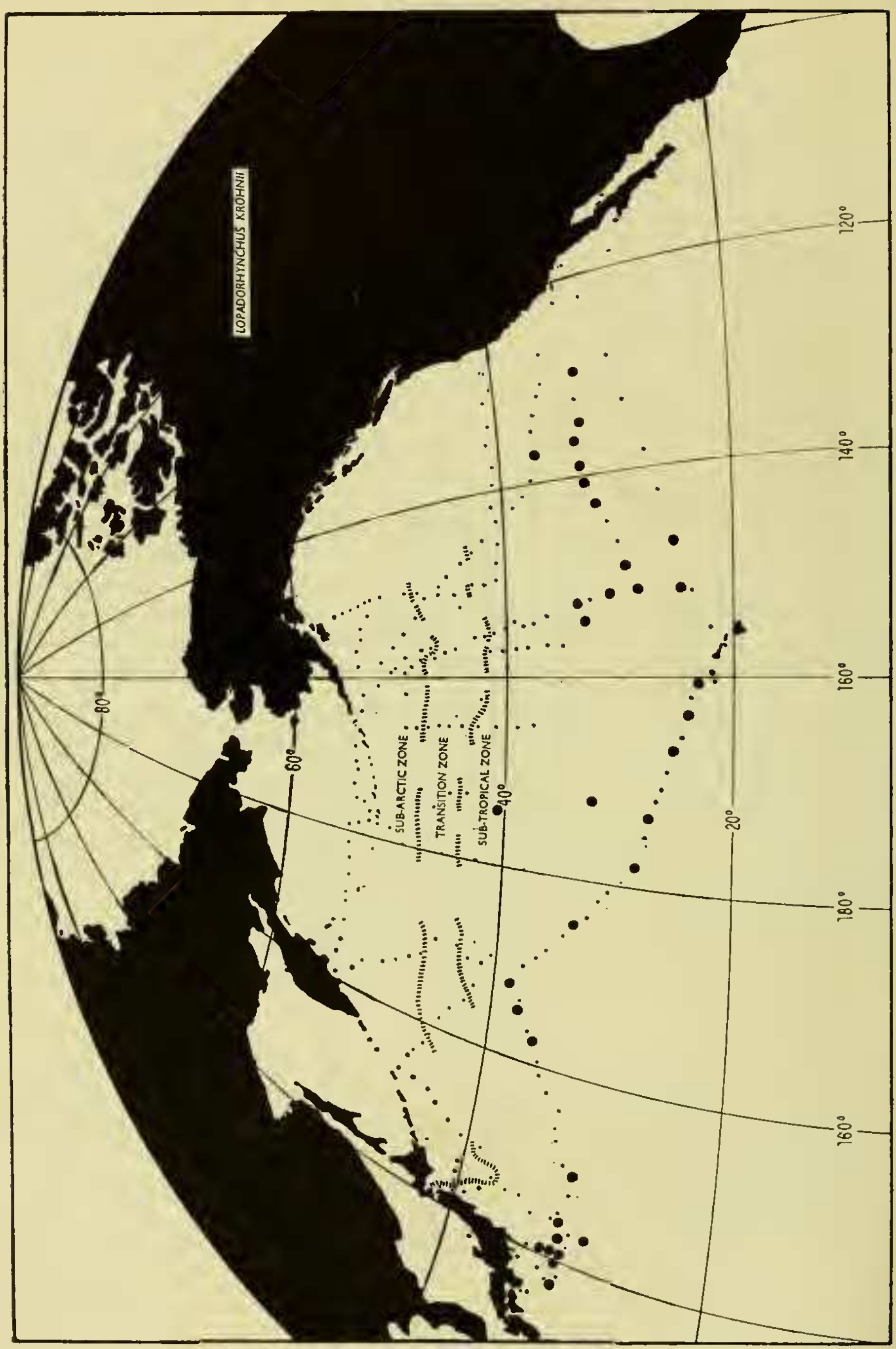

FIG. 52. Occurrence of *Lopadorhynchus krohnii*.

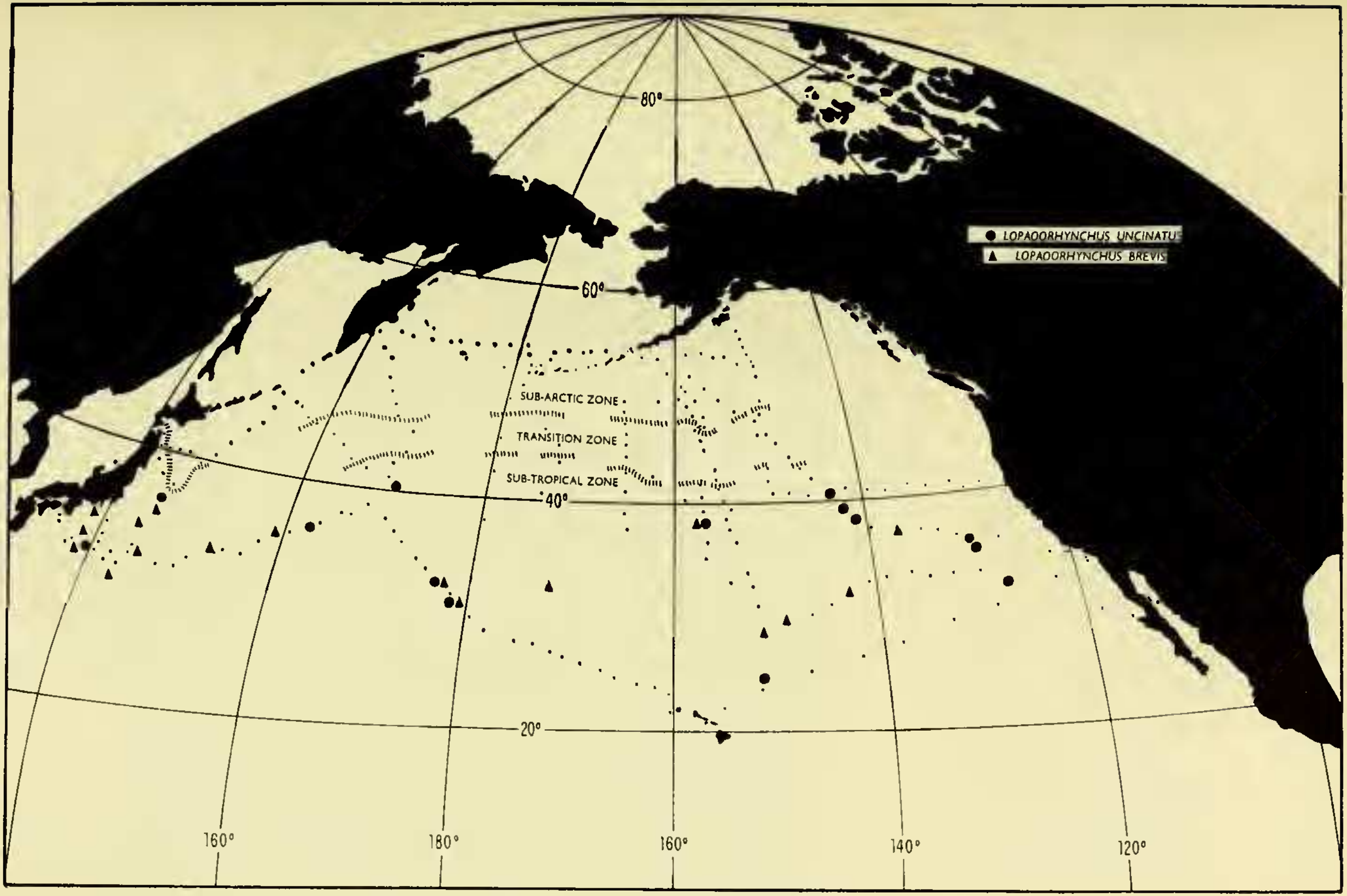

FIG. 53. Occurrence of *Lopadorhynchus uncinatus* and *L. brevis*.

Transition Zone, 43° 08′ N., 156° 08′ E., and Berkeley & Berkeley (1958) later reported it from the Tropical Zone, 1° 58′ N., 83° 49′ W.

PEDINOSOMA

P. curtum was collected at only twelve stations, all east of 164° W., and in the Sub-Tropical Zone except for one record at the southern end of the Transition Zone (Text-fig. 54). It appeared only in nets towed open in the upper 415 metres of water : on only one occasion was more than one specimen collected. The only previous record of *P. curtum* from the North Pacific was made by Berkeley & Berkeley (1960) from 53° 32′ N., 151° 57′ W., and it is altogether too little known to draw conclusions about its distribution. Elsewhere in the world this species is not well known except in the North Atlantic where Reibisch (1895) found it only in Tropical and Sub-Tropical waters.

IOSPILINAE

PHALACROPHORUS

Two species of this genus are reported here, of which *P. pictus* appeared at numerous stations but *P. uniformis* at only one. This singular occurrence of *P. uniformis* at Stn. 126B of the Trans-Pacific Expedition (Text-fig. 55) consisted of fifty-three specimens, equivalent to sixty-two per 1,000 m^3 of water. This is a large number for any polychaete species, making the record particularly remarkable. Previously it was known from the North Pacific only through the records of Treadwell (1943 as *P. attenuatus*) from four stations made by the *Carnegie*, all south of the Transition Zone. In the Atlantic it is known only from Sub-Tropical and Tropical waters (Reibisch, 1895 ; Fauvel, 1916) and may be restricted to these zones in the North Pacific but more records will have to be obtained before this can be confirmed.

P. pictus was collected at numerous stations in the Sub-Arctic Zone, but at only one in the Sub-Tropical, Trans-Pacific Expedition Stn. 123A (Text-fig. 55). It would appear reasonable to consider this latter record an anomaly and treat the species as one restricted to the colder waters. There are, however, numerous literature records of *P. pictus* from Sub-Tropical waters which cannot be overlooked, these include Treadwell (1943, as *P. maculatus*), Uschakov (1957*a*) and Berkeley & Berkeley (1960), as well as others from the Sub-Arctic, Treadwell (1943), Berkeley & Berkeley (1958). It is clear therefore that the almost complete absence of this species from the collections reported here from the Sub-Tropical Zone was a result of its not being caught, rather than its not being there—a major hazard of plankton collecting.

Uschakov (1957*b*) has reported another species, *P. borealis*, from high Arctic waters in the North Pacific, beyond 76° N. This material is identical with that reported here as *P. pictus* and I consider the two species synonymous. It is possible, however, that the material reported as *P. borealis* represents a geographical race restricted to the colder water. This may also be applicable to the North Atlantic

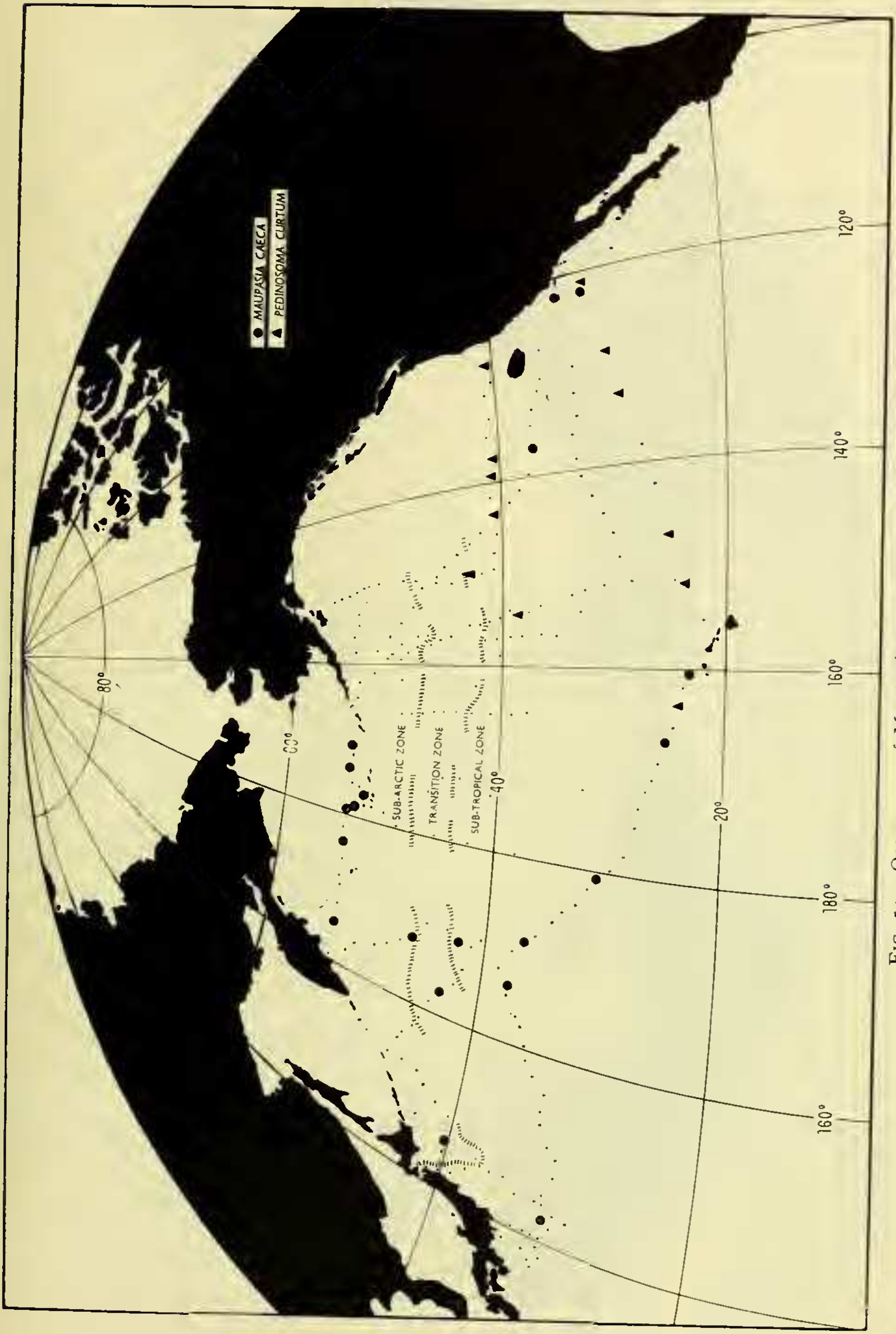

FIG. 54. Occurrence of *Maupasia caeca* and *Pedinosoma curtum*.

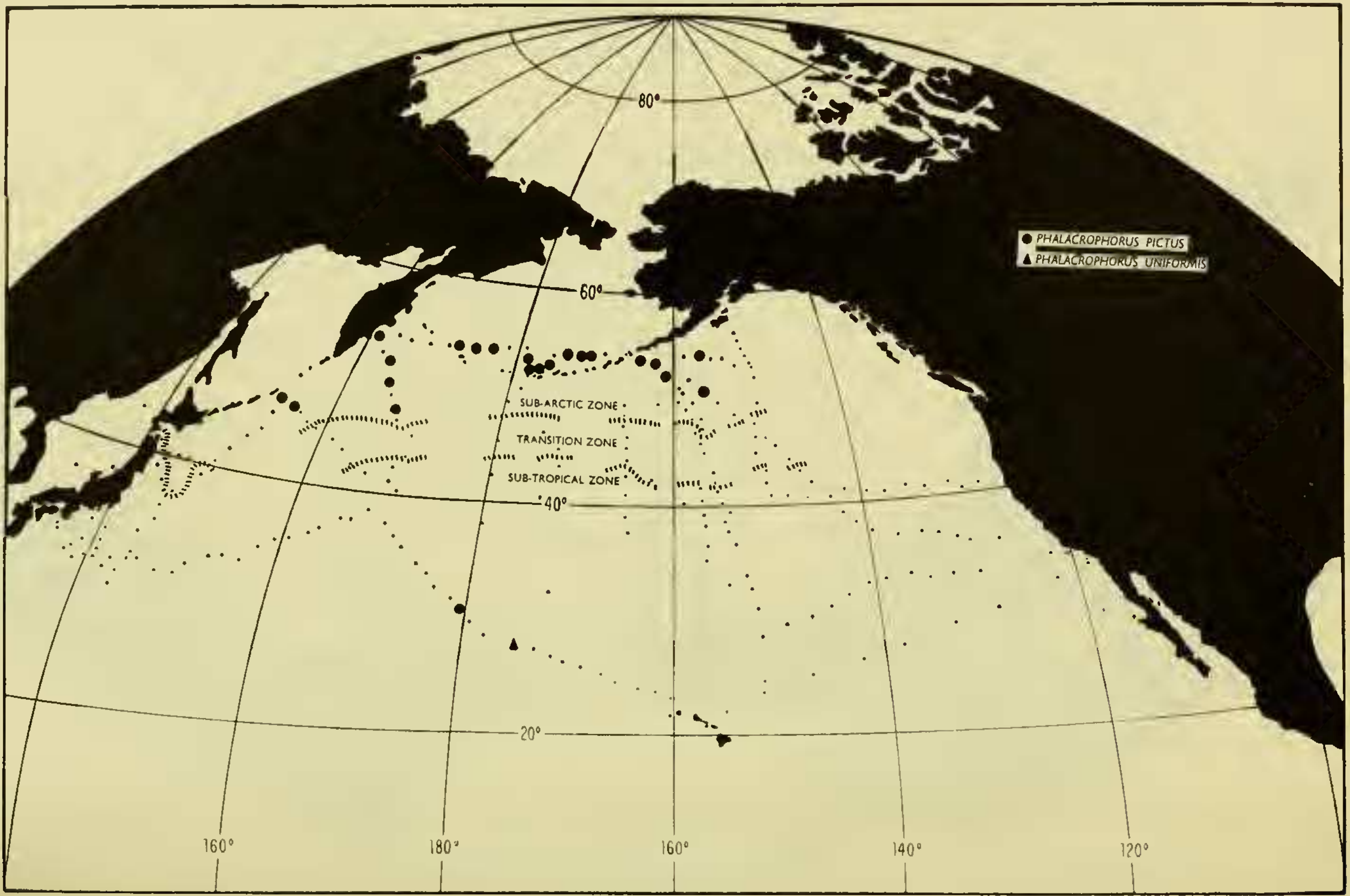

FIG. 55. Occurrence of *Phalacrophorus pictus* and *P. uniformis*.

Ocean where *P. borealis* was first recorded by Reibisch (1895) entirely within Sub-Arctic waters but I would like to see material from a wider geographical range than at present available before drawing conclusions on this point. For the present, however, I think that *P. pictus* must be considered as potentially a cosmopolitan species.

ZOOGEOGRAPHICAL REVIEW

Thirty-three species are reported here of which twenty-one appear to have the northerly limit to their distribution in the North Pacific Ocean at either the northern boundary of the Sub-Tropical Zone or the southern boundary of the Sub-Arctic Zone; they are :

Tomopteridae	Alciopidae	Typhloscolecidae	Lopadorhynchinae
Tomopteris elegans	*Naiades cantrainii*	*Sagitella kowalewskii*	*Lopadorhynchus*
T. planktonis	*Vanadis longissima*	*Travisiopsis lobifera*	*L. uncinatus*
T. ligulata	*V. formosa*		*L. krohnii*
T. apsteini	*V. crystallina*		*L. brevis*
T. nisseni	*V. minuta*		
	V. tagensis		
	Rhynchonerella gracilis		
	R. petersii		
	R. mobii		
	Plotohelmis tenuis		
	Krohnia lepidota		

All of these effectively avoid the main body of the Sub-Arctic water mass in the Sub-Arctic Zone and, in that area of the North Pacific investigated, can be considered Sub-Tropical species. Because there is no definable " line of the Sub-Tropical Convergence ", between sub-tropical and sub-arctic water, stretching across the North Pacific (corresponding to the Sub-Tropical Convergence in the South Atlantic) but rather a Zone of Transition water, these species vary in the extent to which they penetrate beyond the northern boundary of the Sub-Tropical Zone. *Vanadis minuta* and *V. crystallina*, for example, were never found in Transition water but *Tomopteris elegans* and *Travisiopsis lobifera* can be collected there up to the border with the Sub-Arctic Zone. This does not warrant excluding the latter species from the list of Sub-Tropical forms. Indeed further collections may show that all species of this group can invade the Transition Zone, if only during certain seasons.

It has been noted that *Tomopteris planktonis*, *Rhynchonerella gracilis*, *Plotohelmis tenuis* and *Sagitella kowalewskii* may occasionally be found north of 45° N., principally in the North-East Pacific off the coast of British Columbia and Alaska. These species could be carried into this region by the Alaskan gyral (Text-fig. 2) and may be the most tolerant of the Sub-Tropical species. Boden *et al.* (1955) records similar northerly extensions for the distribution of the euphausiids *Nematoscelis difficilis*, *Nematobranchion flexipes* and *Stylocheiron longicorne*. Essentially sub-tropical and/or tropical in their distribution in the North Pacific as recorded by Brinton (1957) these species were found by Banner (1949) to extend to varying degrees north of the southern boundary of the Sub-Arctic off the slope waters of British Columbia. Bradshaw (1959) notes that a similar pattern is found in the foraminiferan *Orbulina universa*. It only remains for extensive collections from the area of the Alaskan gyral to be investigated to establish the geographical and seasonal extension of these and similar species. The fundamental feature of the distribution of all of them, however, is that they avoid the main body of oceanic water in the Sub-Arctic Zone.

It is possible that most of these twenty-one Sub-Tropical pelagic polychaetes occur also in Tropical waters in the Pacific Ocean but investigation of the extent of this will have to await further study. Bieri's (1959) analysis of chaetognath distribution in the North and South Pacific Oceans and Brinton's (1957) similar study on euphausiids draw attention to the great variety of distributional patterns which emerge from the study of a group over such immense areas. Involving so many different zoogeographical regions their work motivates a sense of caution towards any predictions whatsoever concerning distribution in the Pacific Ocean outside the region investigated.

Of the remaining twelve species five are cosmopolitan—*Tomopteris septentrionalis*, *Typhloscolex mülleri*, *Pelagobia longicirrata*, *Maupasia caeca* and *Phalacrophorus pictus*; one is known only from Sub-Arctic and Transition Zone waters of the North Pacific—*Tomopteris pacifica*; one occurs in all hydrological Zones in the Northern Hemisphere but avoids colder water in the Southern Hemisphere—*Rhynchonerella angelini*; and five are known from comparatively few records in the North Pacific and at the present time their distribution need not be examined further—*Travisiopsis levinseni*, *Tr. lanceolata*, *Tr. dubia*, *Phalacrophorus uniformis* and *Pedinosoma curtum*.

Of the Sub-Tropical species *Vanadis minuta* and *V. tagensis* are known only from the Pacific Ocean. It has been noted above that the latter is a deeper-water species, and many more collections from nets closing at depth in other oceans will have to be examined before it can be established as an exclusively Pacific Ocean species. *V. minuta* is a surface water form and one would expect it to have been reported from other oceans if it lived outside the Pacific. In fact this species is similar to *V. crystallina*, which is well known from the Atlantic, and they may have been confused in previously reported collections. I prefer, therefore, to delay suggesting that *V. minuta* is entirely restricted to the Pacific Ocean until more collections from other oceans have been examined.

Of the remaining nineteen species in this group seventeen are known from the North Atlantic Ocean entirely within Tropical and Sub-Tropical waters, although the records from there for a few of them are not numerous. The two which do not inhabit similar zoogeographical regions in the two oceans are *Tomopteris planktonis* and *Tomopteris nisseni*.

The absence of *T. planktonis* from the main body of Sub-Arctic water has been referred to above as entirely unexpected. Known from every other explored water mass in the world I can offer no satisfactory explanation of why this species, hitherto considered as cosmopolitan, should avoid this water. It may, of course, have been missed. Such a possibility, though remote, cannot be overlooked, and need not be accepted as invalidating any conclusions drawn for other species based on similar negative records : it may indeed represent one of the major hazards of reporting on the distribution of zooplankton.

T. nisseni inhabits Sub-Tropical and Tropical waters in the South Atlantic Ocean and similar water in the North Atlantic. In the latter, however, it also extends into Sub-Arctic and Arctic waters and I expected it to be present in the Pacific Sub-Arctic, from which it was, however, entirely absent. As an explanation of the extension of *T. nisseni* (and also *Tomopteris krampi*, *Rhynchonerella angelini* and *Travisiopsis lanceolata*) into the waters of higher latitudes in the North Atlantic, though absent from similar water in the South Atlantic, I suggested (Tebble, 1960) that they represented endemic antarctic elements in arctic waters. There being no endemic pelagic polychaetes in the North Atlantic, Sub-Arctic and Arctic it appeared to me that *T. nisseni* and *T. krampi* might represent there the endemic Antarctic species *T. carpenteri* and similarly *R. angelini* might represent *R. bongraini* and *Travisiopsis lanceolata* the southern hemisphere *Travisiopsis coniceps*. (It follows that the appearance of these four species in the Pacific Sub-Arctic was anticipated.) Only *Rhynchonerella angelini*, however, occurred in sufficiently large numbers there to lend credence to this suggestion, though *Tr. lanceolata* has been found there, but not in sufficient numbers to substantiate any conclusions at present which must await further collections. Not only was *T. nisseni* not present in the Sub-Arctic, but *T. krampi* was not present in any of the samples I examined from the North Pacific, and although Dales (1955) reported it from Monterey Bay, he did not find it in the California Current (Dales, 1957). Disregarding then, for the present, *T. krampi*, it is necessary only to find an explanation for the absence of *T. nisseni* from the Sub-Arctic. This appears to me to be possible through the presence there, and in the Transition Zone only, of *T. pacifica*. This species may be considered as restricted to the Pacific Sub-Arctic and Transition Zones (whether or not it extends into high polar waters is not relevant at present) and it may have replaced *T. nisseni* (and *T. krampi*) in these waters as representative of the endemic antarctic elements—as much as we have seen *Rhynchonerella angelini* represents *R. bongraini*. It appears, therefore, as if *T. nisseni* extends into waters of higher latitudes only when there are no endemic tomopterid elements present. This is the conclusion that can be drawn from the evidence of distribution in the North Pacific and Atlantic Oceans. It is at the same time a reminder that animals are not necessarily the slaves of hydrological characteristics or water masses.

Of the thirty-three species reported here from the North Pacific all except three are also known from the Atlantic (the three exceptions *Tomopteris pacifica*, *Vanadis tagensis* and *Vanadis minuta* have been examined above). It is significant that most of the species making up such a high percentage, 91%, common to both areas, occur in abundance rather than as scattered isolated elements. Specimens of some species, however, in particular *Tomopteris planktonis*, *Typhloscolex mülleri* and *Vanadis longissima*, have characteristics which permit immediate separation of the Pacific from the Atlantic forms. If these particular specimens have been collected as isolated catches they could have been described as new species ; but if they are examined in the light of the wide range over which they, and closely related forms, are known to exist, and in relation to the hydrological boundaries restricting their distribution, the problem can be viewed less empirically. Thus there is abundant evidence that the species which vary distinctively in form, range, within their hydrological limits, throughout the South Pacific into the Indian and Atlantic Oceans ; in the North Pacific they either meet a hydrological barrier which restricts their movement northwards, or enter a circulation which can be an effective isolating mechanism.

Thus, *T. planktonis* ranges throughout the southern hemisphere to the North Pacific, where it is restricted in its distribution at the southern boundary of the Sub-Arctic Zone. It is thus at the very edge of its range that morphological differences occur in some members of the population. *Typhloscolex mülleri* is very well known as a cosmopolitan polychaete, but it is only in the Sub-Arctic waters of the North Pacific that a cold water ecotype has been found. Although abundant in the Antarctic, no isolating mechanism appears to have been effective to produce a comparable anti-boreal population. It is apparent that, within the Sub-Arctic Zone, the necessary isolating circulation has been effective, and it would be of the greatest interest if the hydrographers could indicate the limits of such a circulation In the case of *T. mülleri* this must be different from that applying to an endemic sub-arctic species, for in this species the cold water ecotype is restricted but the other members of the population are not.

The presence of a few specimens of *V. longissima* in and near the Transition Zone which can be instantly separated from other members of the species by the possession of black markings on the eyes suggests that we might be dealing here with a separate physiological race. At the southern extremity of its distribution in the southern hemisphere *V. longissima* meets the endemic antarctic *V. antarctica*. These two are very similar morphologically and may, in fact be semi-sympatric species. Such ecological allopatry combined with genetical contiguity probably represents a stage towards complete separation of the species. The physiological race (?) here reported from the North Pacific may be an earlier step in this process.

McGowan (1960) has examined the distribution of the aberrant planktonic worm *Poeobius meseres* Heath, in the North Pacific Ocean. The systematic relationships of this animal are problematical and I do not intend to comment here on whether or not it is a polychaete ; it may be noted, however, that McGowan found *P. meseres* mainly in the Sub-Arctic and Transition Zones. A few specimens he found to the south of the latter region he considered non-endemic, having been carried in from the north.

APPENDIX I

The actual number of specimens collected at each station is recorded here. When only a fraction of a sample was examined this is indicated and allowance made in the column headed " Volume of water filtered, m³ ".

Table I

Stns. in the Sub-Tropical and Transition Zones

Trans-Pacific Expedition	Stns. 1 to 18. Stns. 51 to 60. Stns. 70, 74 to 77, 79 to 143.
Northern Holiday Expedition	Stns. 2 to 18. Stns. 44 to 66.
Chinook Expedition	Stns. 1 to 5. Stns. 7 to 9.
P.O.F.I. *Hugh M. Smith*, Cruise No. 30	Stns. 26 to 32. Stns. 44 to 79. Stns. 87 to 102.

Table II

Stns. in the Sub-Arctic Zone

Trans-Pacific Expedition	Stns. 19 to 50. Stns. 61 to 69, 71 to 73, 78.
Northern Holiday Expedition	Stns. 19 to 40.
Chinook Expedition	Stn. 6.
P.O.F.I. *Hugh M. Smith*, Cruise No. 30	Stns. 37. Stns. 80 to 86.

Table III

Dept. of Oceanography, University of Washington, Seattle, Washington, Collections

Cruise BB–199—MWT : 50 records.
Cruise BB–202—MWT : 3 records.

TABLE I.—*Species Collected at Stns. in the Sub-Tropical and Transition Zones**

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m³)	*Tomopteris elegans*	*Tomopteris septentrionalis*	*Tomopteris planktonis*	*Tomopteris ligulata*	*Tomopteris nisseni*	*Tomopteris apsteini*	*Tomopteris* not identifiable	*Nacades cantrainii*	*Vanadis formosa*	*Vanadis crystallina*	*Vanadis minuta*	*Vanadis longissima*	*Vanadis tagensis*	*Rhynchonerella gracilis*	*Rhynchonerella mobii*	*Rhynchonerella petersii*	*Rhynchonerella angelini*	*Plotohelmis tenuis*	*Krohnia lepidota*	*Alciopid* fragments	*Typhloscolex mulleri*	*Sagitella kowalewskii*	*Travisiopsis lobifera*	*Lopadorhynchus brevis*	*Lopadorhynchus uncinatus*	*Lopadorhynchus krohnii*	*Pelagobia longicirrata*	*Maupasia caeca*
		TRANS-PACIFIC EXPEDITION																															
1A	33° 57·5′	122° 28′ W.	23.vii.53	0–145	444		32																6		×								
B	,,	,,	,,	0–330	816	2	19																1		×	1	1	1				1	1
3A	35° 04·9′	127° 37·7′ W.	25.vii.53	0–165	531	47						153									1		1					1					
B	,,	,,	,,	0–320	1,130	122	1					71						1					2				1	1					
4A	35° 46·8′	130° 02·5′ W.	26.vii.53	0–165	525	51																			×								
B	,,	,,	,,	165–330	555	72			3									1							×								
C	,,	,,	,,	330–495	555	1																				1	1						
D	,,	,,	,,	0–1,015	2,795	163	8					32				1									×	1				1		5	
5A	35° 54·0′	131° 44·0′ W.	27.vii.53	0–135	445	10	1					9											1					1					
B	,,	,,	,,	0–355	1,035	44	1					3	1			1		2								1							
6A	36° 09·2′	133° 20·0′ W.	27.vii.53	0–115	411	131							2	1							1				×								
B	,,	,,	,,	0–260	970	125		1					1	3	1																		
7A	36° 21·8′	134° 53·0′ W.	28.vii.53	0–170	251	64				2				1					1						×		1						
B	,,	,,	,,	170–340	464	64																				3							
C	,,	,,	,,	340–510	464					1		1															1						
D	,,	,,	,,	510–680	464	13																					1					1	
E	,,	,,	,,	0–1,035	2,120	126	9																			3	2					3	
8A	36° 44·0′	137° 23·7′ W.	29.vii.53	0–145	500	90								1		1									×		2		1		2		1
B	,,	,,	,,	0–310	1,212	306											4		3			3					2				3		
9A	37° 00·0′	140° 01·5′ W.	29.vii.53	0–170	524	142	1	1				43	1			1	2		2			1		1		1	1	1					
B	,,	,,	,,	170–340	705	4																				1						2	
C	,,	,,	,,	340–510	705	1																											
D	,,	,,	,,	510–680	705	1																											
E	,,	,,	,,	0–1,035	2,386	272	1					77	1	1											×	1	1					6	
10A	38° 22·3′	141° 23·2′ W.	31.vii.53	0–120	362	144						14									2	1			×	2						1	
B	,,	,,	,,	0–230	1,038	172		1													2									1			
11A	39° 35·6′	142° 33·0′ W.	1.viii.53	0–170	801	1,058						191									4				×	1		1		1			
B	,,	,,	,,	170–340	889	35												1								5							
D	,,	,,	,,	510–680	889	32	1											1					1		×	3	4					3	
E	,,	,,	,,	680–850	889							5															2					10	
F	,,	,,	,,	0–1,280	4,815	141	2						1													2	2	1				14	
12A*	40° 26·9′	143° 32·0′ W.	2.viii.53	0–170	639	652						108					1				1				×	1		1				1	
B	,,	,,	,,	170–340	667																					1							
C	,,	,,	,,	340–510	667			2																		5	2						
D	,,	,,	,,	510–680	667	6	9					13														2	2	1				1	
E*	,,	,,	,,	680–850	667							5									1				×							12	
F	,,	,,	,,	0–1,280	3,680	281								1								3	1		×	3	3			1		19	

* For footnotes see p. 483.

TABLE I—*contd.*

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m³)	*Tomopteris elegans*	*Tomopteris septentrionalis*	*Tomopteris planktonis*	*Tomopteris ligulata*	*Tomopteris nisseni*	*Tomopteris apsteini*	*Tomopteris* not identifiable	*Naiades cantrainii*	*Vanadis formosa*	*Vanadis crystallina*	*Vanadis minuta*	*Vanadis longissima*	*Vanadis tagensis*	*Rhynchonerella gracilis*	*Rhynchonerella mobii*	*Rhynchonerella petersii*	*Rhynchonerella angelini*	*Plotohelmis tenuis*	*Krohnia lepidota*	*Alciopid* fragments	*Typhloscolex mülleri*	*Sagitella kowalewskii*	*Travisiopsis lobifera*	*Lopadorhynchus brevis*	*Lopadorhynchus uncinatus*	*Lopadorhynchus krohnii*	*Pelagobia longicirrata*	*Maupasia caeca*
13A	41° 53·8′	145° 13·0′ W.	3.viii.53	0–125	431	205	6					3														4						12	
B	,,	,,	,,	0–340	876	393	7					123													×	3		2				10	
14A[1]	42° 57·5′	146° 14·8′ W.	3.viii.53	0–175	663	142	4			1		3														1						2	
B	,,	,,	,,	0–380	254	47	9					27														2							
15A	44° 01·9′	147° 29·2′ W.	4.viii.53	0–170	586	16						24														1		1					
B	,,	,,	,,	135–350	332							16														1		1					
16A	44°59′	148° 46·5′ W.	4.viii.53	0–165	1,202	4	4					101														3						1	
B	,,	,,	,,	165–330	685																					1	1						
16C	44° 59′	148° 4·65′ W.	4.viii.53	330–495	685		1																										
D	,,	,,	,,	495–660	685							3																				3	
E[2]	,,	,,	,,	0–980	821		1					46														1						7	
17A	46° 00·0′	149° 54·0′ W.	5.viii.53	0–135	441	48	91																										
B	,,	,,	,,	160–295	370	9	5					20														4							
18A	47° 14·0′	151° 43·0′ W.	6.viii.53	0–169	443		4					19										1				1							
B[2]	,,	,,	,,	0–318	1,295		44																			2							
51A	45° 05·5′	170° 08·5′ E.	7.ix.53	0–145	440		7					76					1		1		1												
B	,,	,,	,,	0–330	934		18					64										2				16							
52A	43° 28·1′	170° 37·3′ E.	8.ix.53	0–155	500		19	1				77														2							
B	,,	,,	,,	155–260	370		9					18											4		×	12	3						
53A	42° 07·9′	169° 28·1′ E.	8.ix.53	0–190	933	3						19	1			5					1		3		×		3						
B	,,	,,	,,	140–295	500							30										1	1			2							1
C	,,	,,	,,	290–545	425							1																				2	
54A	40°1 4·5′	170° 02·3′ E.	9.ix.53	0–170	810	8			1			82				1	2					2	1		×			1					
B	,,	,,	,,	170–340	705							11								1					×	17	2					1	
C	,,	,,	,,	340–510	705							1														10	2	1				2	
D[4]	,,	,,	,,	0–1,015	3,650	1	2	1				14														9	9			1		4	
55A	41° 19·0′	168° 20·2′ E.	9.ix.53	0–169	463	1						9			1										×								
B	,,	,,	,,	153–288	388							30											1		×	8		1					
56A	41° 49·0′	166° 38·6′ E.	10.ix.53	0–135	330							29					1				1			1			1	2					
B	,,	,,	,,	0–258	1,053	2						35							1	1					×	9		1					

TABLE I—*contd.*

Sto. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m³)	*Tomopteris elegans*	*Tomopteris septentrionalis*	*Tomopteris planktonis*	*Tomopteris ligulata*	*Tomopteris nisseni*	*Tomopteris apsteini*	*Tomopteris* not identifiable	*Naiades cantrainii*	*Vanadis formosa*	*Vanadis crystallina*	*Vanadis minuta*	*Vanadis longissima*	*Vanadis tagensis*	*Rhynchonerella gracilis*	*Rhynchonerella mobii*	*Rhynchonerella petersii*	*Rhynchonerella angelinii*	*Plotohelmis tenuis*	*Krohnia lepidota*	*Alciopid* fragments	*Typhloscolex mülleri*	*Sagitella kowalewskii*	*Travisiopsis lobifera*	*Lopadorhynchus brevis*	*Lopadorhynchus uncinatus*	*Lopadorhynchus krohnii*	*Pelagobia longicirrata*	*Maupasia caeca*
57A	42° 41·4′	164° 57·1′ E.	11.ix.53	0–160	487		27					52														3	3						
B'	,,	,,	,,	144–312	610		8					32														3							
C'	,,	,,	,,	318–491	650																	1				2						24	
58A	43° 23·4′	163° 12·9′ E.	12.ix.53	0–164	499		3					19													+	1							
B	,,	,,	,,	1153–18	390		12					90														12	1					2	1
59A	44° 06·0′	161° 39·0′ E.	13.ix.53	0–163	955							36										1				5							
B	,,	,,	,,	163–326	815							13											1		×	6	1						
C	,,	,,	,,	326–490	815							6														1	1					1	
D	,,	,,	,,	490–653	815							4																				26	
E•	,,	,,	,,	0–980	3,890		2					34														5	7					42	
60A	44° 46·1′	159° 54·9′ E.	13 ix.53	0–129	464		1					8														7	1						
B	,,	,,	,,	0–258	1,059		34	21				10											1		×	25							
70A•	39° 44·0′	148° 24·0′ E.	19.ix.53	0–165	449							7												1			3	1					
E•	,,	,,	,,	0–1,016	3,442		2					56					1								×	5	2	1					
74A	41° 22·2′	142° 18·3′ E.	22.ix.53	0–118	459		2					2														3							
B	,,	,,	,,	160–288	1,110		15	3				5										2				2							
75A	40° 54·6′	142° 18·1′ E.	28.ix.53	0–106	505							10																					
B	,,	,,	,,	121–225	444		14					61										1				1							
76A	39° 56·4′	143° 38·5′ E.	28.ix.53	0–163	1,200			3									1		4					2	×	5	6	1				5	
D	,,	,,	,,	490–652	1,424		4																			1						4	
E	,,	,,	,,	0–980	3,680	1	8	2			1	20							2						×	4	4					5	
77A	38° 58·6′	144° 51·0′ E.	29 ix.53	0–124	569							36					2		4							3							
B•	,,	,,	,,	149–318	1,054	3	1					24														2							
79B	26° 23·2′	145° 30·4′ E.	30.ix.53	139–324	314	5				1		7																		1			
C	,,	,,	,,	318–720	555							5															1					1	
80A	35° 04·5′	145° 07·5′ E.	1.x.53	0–112	430	7			4			9				1	3				1		1	2	×	1	2	2	1				
B	,,	,,	,,	0–258	1,020	17		11		1					1		2		2		2				×	1		2					
81A	34° 06·0′	144° 36·5′ E.	2.x.53	0–127	450							9				1												1	1				
B	,,	,,	,,	147–318	444	3				4		10																					
82A	32° 59·6′	144° 15·0′ E.	2.x.53	0–129	464							3				2									×	1	1						
85A	31° 08·3′	143° 41·0′ E.	3.x.53	0–164	536							1											1		×	1	2						
B	,,	,,	,,	0–225	1,662							9					1	1		1			1		×	1	1	3					

TABLE 1—*contd.*

Sto. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m³)	*Tomopteris elegans*	*Tomopteris septentrionalis*	*Tomopteris planktonis*	*Tomopteris ligulata*	*Tomopteris nisseni*	*Tomopteris apsteini*	*Tomopteris* not identifiable	*Naiades cantrainii*	*Vanadis formosa*	*Vanadis crystallina*	*Vanadis minuta*	*Vanadis longissima*	*Vanadis tagensis*	*Rhynchonerella gracilis*	*Rhynchonerella mobii*	*Rhynchonerella petersii*	*Rhynchonerella angelini*	*Plotohelmis tenuis*	*Krohnia lepidota*	*Alciopid* fragments	*Typhloscolex mülleri*	*Sagitella kowalewskii*	*Travisiopsis lobifera*	*Lopadorhynchus brevis*	*Lopadorhynchus uncinatus*	*Lopadorhynchus krohnii*	*Pelagobia longicirrata*	*Maupasia caeca*
84A	30° 09·0′	143° 15·7′ E.	3.x.53	0–153	468							16				3	1							1	×	1	2	1	1		1		
B	,,	,,	,,	135–300	444							14													×								
C	,,	,,	,,	369–525	14,80																					1							
85A*	31° 23·4′	141° 23·6′ E.	4.x.53	0–153	440	1		3				4			3		1		1						×		3	8					
B	,,	,,	,,	139–258	1,166							8														1							
86A*	32° 26·8′	140° 36·6′ E.	5.x.53	0–153	430	1		1				2				1				1					×	1	14	6			2		
B	,,	,,	,,	0–369	1,240	3		4				17				5			1	1				1	×	3	5	8			2		
87A	33° 23·5′	140° 27·9′ E.	6.x.53	0–177	450	1		1	1			8			1	4								1	×	1	5	9			1		
B*	,,	,,	,,	0–397	735	1						33			1	1				1					×	4	7	10					
88A*	34° 18·8′	140° 11·0′ E.	6.x.53	0–164	465	2		2				6				3				1	1				×	1	6						
89A	34° 21·5′	138° 40·5′ E.	15.x.53	0–138	703			1			1	4	1			4			1		2				×	3	1		1				
B	,,	,,	,,	120–260	426	3				1		4													×								
91A*	33° 16·0′	138° 10·0′ E.	16.x.53	0–150	420			1		2		4											1	1	×	2							
B	,,	,,	,,	0–290	870							8					1						1		×	3	1		1				
92A	32° 45·0′	137° 47·5′ E.	16.x.53	0–110	432			2				12							1	1					×	6	3						
B	,,	,,	,,	0–295	1,058							9				1			2						×	6	1						
93A*	33° 25·2′	135° 06·0′ E.	24.x.53	0–110	565							4							1						×	2	3					1	1
94A	32° 59·5′	135° 57·0′ E.	24.x.53	0–140	492																				×	4							
B	,,	,,	,,	140–310	444	4						3														1							
95A	32° 22·8′	137° 06·7′ E.	24.x.53	0–110	419	1	1	1											1	1				1	×	2					2		
B	,,	,,	,,	133–290	370							5														1							
C	,,	,,	,,	295–520	1,572							3																					
96A*	31° 44·3′	138° 00·0′ E.	25.x.53	0–115	434							4				1					1			1	×	11	1		1			1	
B	,,	,,	,,	110–300	1,147	2						5			1										×							1	
97A	32° 02·3′	139° 25·1′ E.	25.x.53	0–170	756						1	21	1											4	×	3	6				1		
B	,,	,,	,,	170–340	1,424	3						3														1							
C	,,	,,	,,	140–510	1,424							8															6					1	
D	,,	,,	,,	210–680	1,424							7																					
E	,,	,,	,,	0–1015	4,345			1				5				1									×		1			1			
98A	32° 03·3′	141° 04·1′ E.	26.x.53	0–155	421			1				4												1			7				1		
B	,,	,,	,,	0–288	770	3	3									1	1	1							×		2	6			2		
99A	31° 53·3′	142° 11·7′ E.	26.x.53	0–150	423	1						7	1			1	1				1				×		8	54			3		1
B	,,	,,	,,	160–335	426	4		4			1	10						1					1		×		1						

TABLE 1—*contd.*

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m³)	*Tomopteris elegans*	*Tomopteris septentrionalis*	*Tomopteris planktonis*	*Tomopteris ligulata*	*Tomopteris nisseni*	*Tomopteris apsteini*	*Tomopteris* not identifiable	*Naiades cantrainii*	*Vanadis formosa*	*Vanadis crystallina*	*Vanadis minuta*	*Vanadis longissima*	*Vanadis tagensis*	*Rhynchonerella gracilis*	*Rhynchonerella mobii*	*Rhynchonerella petersii*	*Rhynchonerella angelini*	*Plotohelmis tenuis*	*Krohnia lepidota*	*Alciopid* fragments	*Typhloscolex mulleri*	*Sagitella kowalewskii*	*Travisiopsis lobifera*	*Lopadorhynchus brevis*	*Lopadorhynchus uncinatus*	*Lopadorhynchus krohnii*	*Pelagobia longicirrata*	*Maupasia caeca*
100A	32° 14·0′	144° 02·1′ E.	29.x.53	0–115	464	1						5			1	1									×	3	3	5			1		
101A	32° 10·0′	145° 53·0′ E.	29.x.53	0–165	418			2				11			2		1						1		×	2	1	2	1				
B	"	"	"	140–275	426							11								1						1		18					
102A	31° 57·0′	147° 53·5′ E.	30.x.53	0–155	321			1				4		1	1	1	6		1						×			1					
103A	31° 49·1′	149° 58·0′ E.	30.x.53	0–175	458	5		2	1			10				3	1		1						×	1	4	12			1		
B	"	"	"	145–290	426	3		7	1	2		8			1			1					2		×								
104A	32° 36·8′	151° 27·4′ E.	31.x.53	0–140	373	8		1				13	2				8				1						3	1					
B	"	"	"	175–265	388	5		6	1	3		5						1					3		×			30					
105A	33° 09·5′	153° 00·0′ E.	31.x.53	0–175	362	6		3			1	14				1	2						1		×	3	4	6					
B	"	"	"	0–290	715	2		8				14			2	3	2						2		×		8		1				
106A	33° 33·9′	154° 29·1′ E.	1.xi.53	0–165	425							8				1	3						1	1	×	2	3						
B	"	"	"	130–300	703							12											1		×			1					
107A	34° 07·0′	156° 11·0′ E.	2.xi.53	0–160	553							1				7	2		1						×			5					
B	"	"	"	0–305	986	1						3				1	1											4					
C¹⁶	"	"	"	0–530	3.150												1				1												
108A	34° 44·8′	157° 39·5′ E.	2.xi.53	0–115	491			1				15			1				2			1	1		×	13	10	6					
B	"	"	"	130–300	1,202							7						2								2	2						
109A	35° 14·0′	159° 04·0′ E.	3.xi.53	0–120	446			1	1		1	13		1		3			2			1			×	3	2	3	1			1	
B	"	"	"	0–330	1,012	7	1	4	1			12				2			1						×	1	2	1					
110A	35° 40·0′	160° 43·0′ E.	3.xi.53	0–85	486	7	7		1			11			1	1	1		6					1	×	3	5	12					
111A	36° 04·0′	162° 13·5′ E.	4.xi.53	0–155	411	1						9	1	1							1			1				2					
B	"	"	"	0–275	871							61	1			1	1		2		1			4	×	3	3	1		1	2		
112A	36° 35·0′	163° 46·0′ E.	4.xi.53	0–135	499	5		1					1		1	5			1						×		1	1					
B	"	"	"	160–275	462																				×	8	1						
113A	37° 28·0′	165° 16·0′ E.	5.xi.53	0–150	380		1					4				4	1		1						×	1	1						
B	"	"	"	0–315	842		3									3	1							1	×			1			1	1	
114A	37° 53·5′	166° 56·7′ E.	5.xi.53	0–160	462	2			3							4	1	1							×								
B	"	"	"	150–385	444	1																				1							
115A	38° 31·5′	168° 31·5′ E.	0 xi 53	0–165	394	1						7				4	1		1		1			1	×		1	1					1
B	"	"	"	0–330	806	4		7				21			1	4	1		1				1	1	×	2			1		1		
116A	37° 40·5′	170° 06·2′ E.	7.xi.53	0–105	415	1		2	2			5				1			4		1				×		1	1					
B	"	"	"	0–280	920	4	1	3	2			1		1		1	1		1						×	1	1	1					

TABLE I—*contd.*

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m³)	*Tomopteris elegans*	*Tomopteris septentrionalis*	*Tomopteris planktonis*	*Tomopteris ligulata*	*Tomopteris nisseni*	*Tomopteris apsteini*	*Tomopteris* not identifiable	*Naiades cantrainii*	*Vanadis formosa*	*Vanadis crystallina*	*Vanadis minuta*	*Vanadis longissima*	*Vanadis lagensis*	*Rhynchonerella gracilis*	*Rhynchonerella mobii*	*Rhynchonerella petersii*	*Rhynchonerella angelini*	*Plotohelmis tenuis*	*Krohnia lepidota*	Alciopid fragments	*Typhloscolex mulleri*	*Sagitella kowalewskii*	*Travisiopsis lobifera*	*Lopadorhynchus brevis*	*Lopadorhynchus uncinatus*	*Lopadorhynchus krohnii*	*Pelagobia longicirrata*	*Maupasia caeca*
117A	36° 35·0′	171° 26·0′ E.	7.xi.53	0–145	415	3	4									1			1						×								
B	"	"	"	150–335	1,092																	1											
C	"	"	"	320–600	1,258							2														1	1	1					1
118A	35° 36·8′	172° 43·7′ E.	8.xi.53	0–155	387	1						20	1		1	2	1		2							1	4	4					
B^{11}	"	"	"	0–345	877	24		5		2		16						1					1		×	5	1	1					
119B	34° 30·5′	174° 04·0′ E.	8.xi.53	310–370	444	9		3	5	1								1	1	1					×								
120A	33° 23·1′	175° 13·2′ E.	9.xi.53	0–140	466	9			1	3			2		1	1	1		1					3	×	1	1	1	1		1		
B	"	"	"	145–320	407			1	6			2											1				2	2					
C	"	"	"	355–535	629		1					5																					
121A	32° 34·1′	176° 44·8′ E.	10.xi.53	0–140	453	10		5	1			3	1			1					1			1	×	1	1	1	1	2			
B	"	"	"	135–220	426	2		2				8						1	1				1		×		1						
123A^{14}	30° 36·8′	179° 30·0′ E.	11.xi.53	0–130	524				1			1	1	1		9	1				1			1	×		1		1	1			1
B	"	"	"	130–260	407	1			3	1								1	1						×								
124A	29° 39·0′	179° 09·8′ W.	10.xi.53	0–135	677	6						6				4							1	1	×	1							
B	"	"	"	150–325	1,147	2						3															1						
C	"	"	"	335–515	1,332																												
125A	28° 38·0′	178° 01·8′ W.	11.xi.53	0–142	457	1			1		1	3		1		3			2	1					×	2	2				2		
B	"	"	"	146–349	1,147							9						1							×								
126A	27° 58·2′	175° 01·9′ W.	13.xi.53	0–131	408							7			1	2			1						×		2						
B^{10}	"	"	"	0–259	858	4		3				9			1	4	1				1	3			×		2						
127B	27° 32·0′	173° 28·5′ W.	13.xi.53	146–295	705	2		2	5		2	3													×	1	2				2		
128B	26° 58·8′	171° 55·1′ W.	14.xi.53	153–259	1,020	4				2	1	4			1			1		1			1	1	×	1	1						
129A	26° 28·5′	170° 23·0′ W.	14.xi.53	0–109	411	12		1							1										×		1						
B	"	"	"	0–264	920	13		10	4	1		2				4					1			1	×	1	1						
130B	25° 52·2′	168° 42·7′ W.	15.xi.53	123–290	704	11		1			1	2									1				×	4	2						
131A	23° 12·4′	166° 56·0′ W.	15.xi.53	0–123	526				1			9		1		8					1				×		4						
B	"	"	"	0–307	900	7		4	3			21													×		4				1		1
132A	24° 38·0′	165° 22·0′ W.	16.xi.53	0–181	398			1				2													×	1	1						
B	"	"	"	153–345	850	2		4				2			1	1									×		4						
133A^{14}	23° 53·3′	163° 39·6′ W.	17.xi.53	0–144	457							3		3		5									×		1						
B	"	"	"	0–277	968	1						7			1	7					1				×		1				1		

TABLE 1—*contd.*

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m³)	*Tomopteris elegans*	*Tomopteris septentrionalis*	*Tomopteris planktonis*	*Tomopteris ligulata*	*Tomopteris nisseni*	*Tomopteris apsteini*	*Tomopteris* not identifiable	*Naiades cantrainii*	*Vanadis formosa*	*Vanadis crystallina*	*Vanadis minuta*	*Vanadis longissima*	*Vanadis tagensis*	*Rhynchonerella gracilis*	*Rhynchonerella mobii*	*Rhynchonerella petersii*	*Rhynchonerella angelini*	*Plotohelmis tenuis*	*Krohnia lepidota*	*Alciopid* fragments	*Typhloscolex mulleri*	*Sagitella kowalewskii*	*Travisiopsis lobifera*	*Lopadorhynchus brevis*	*Lopadorhynchus uncinatus*	*Lopadorhynchus krohnii*	*Pelagobia longicirrata*	*Maupasia caeca*
134A	23° 26·3′	161° 49·6′ W.	17.xi.53	0–129	441							2	1			3					1				×	2	1						
B	,,	,,	,,	0–283	1,015	3		1				4			1	5					1				×	2	3						
153A	22° 50·0′	160° 05·6′ W.	18.xi.53	0–151	405	2						3				3				1					×	1		1					1
B	,,	,,	,,	146–290	1,202	2		2	3			6									1						1				1		2
136A	21° 42′	156° 19′ W.	21.xi.53	0–375	793	2						5			1	8									×	1	1						
137A[13]	23° 05′	152° 02′ W.	22.xi.53	0–320	714	14										4			1		1	1	1		×	1	1						
138A[13]	24° 27′	147° 32′ W.	23.xi.53	0–345	769	7			2			7	1			5				1	1			1	×		3				2		
139A	25° 48′	142° 43′ W.	24.xi.53	0–320	895	5		1	2	1						1			1						×	1	2						
140A	26° 57′	138° 22′ W.	25.xi.53	0–325	645	3		1	1						1	2				1					×	3	6	1					
141A[13]	28° 14′	133° 38′ W.	26.xi.53	0–325	641	3		2				4		1		2								1	×	1	8						
142A[13]	29° 31′	128° 47′ W.	27.xi.53	0–300	788	4		5					1						1						×	1	1						
143A[13]	31° 00′	123° 00′ W.	28.xi.53	0–415	738	65										3					1				×								1
		NORTHERN HOLIDAY EXPEDITION																															
2[13]	40° 23′	127° 04′ W.	1.viii.51	215	626	4	4		1														69		×	3	1	5				1	
3	40° 28′	129° 05′ W.	1.viii.51	210	789	6																											
4	40° 30′	131° 08′ W.	2.viii.51	183	832																												
5	30′ 22′	133° 06′ W.	3.viii.51	208	758	10						50											2			2							
6	40° 29′	134° 58′ W.	4.viii.51	213	739		2					9														1							
7[13]	40° 28′	137° 38′ W.	4.viii.51	213	728	14		2																		2		5					
8[14]	40° 21·5′	139° 24·5′ W.	5.viii.51	208	706	6						19													×	1							
9	40° 28′	141° 57′ W.	6.viii.51	196	723	7																											
11	40° 32′	145° 47′ W.	9.viii.51	203	745	1	1					8																					
12	40° 34′	147° 54·5′ W.	9.viii.51	226	699																					2							
13	30° 34′	149° 43′ W.	10.viii.51	215	721	6						20													×	1							
14	41° 41′	150° 00′ W.	11 viii.51	210	655	73						32									1				×	1	1						

TABLE 1—*contd.*

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m³)	*Tomopteris elegans*	*Tomopteris septentrionalis*	*Tomopteris planktonis*	*Tomopteris ligulata*	*Tomopteris nisseni*	*Tomopteris apsteini*	*Tomopteris* not identifiable	*Naiades cantrainii*	*Vanadis formosa*	*Vanadis crystallina*	*Vanadis minuta*	*Vanadis longissima*	*Vanadis tagensis*	*Rhynchonerella gracilis*	*Rhynchonerella mobii*	*Rhynchonerella petersii*	*Rhynchanerella angelini*	*Plotohelmis tenuis*	*Krohnia lepidota*	*Alciopid* fragments	*Typhloscolex mülleri*	*Sagitella kowalewskii*	*Travisiopsis lobifera*	*Lopadorhynchus brevis*	*Lopadorhynchus uncinatus*	*Lopadorhynchus krohnii*	*Pelagobia longicirrata*	*Maupasia caeca*
15^{18}	43° 8·5′	149° 50′ W.	11.viii.51	214	760	172						10														1							
16	44° 35′	150° 21′ W.	12.viii.51	191	921	5																				1							
17^{16}	45° 58·5′	150° 11·5′ W.	13.viii.51	218	711	4																					1						
18	47° 25·5′	150° 4·5′ W.	13.viii.51	200	708																					2							
44	43° 14′	155° 55·5′ W.	8.ix.51	204	915	22						241																					
45	42° 15′	155° 36′ W.	9.ix.51	170	905	30						91									1					2							
46	41° 20′	155° 20′ W.	9.ix.51	212	811	6	36					109																					
47^{16}	40° 09′	155° 03′ W.	10.ix.51	195	408	10						201										1			×								
48	39° 18′	154° 38′ W.	11.ix.51	211	700	1																											
49^{18}	38° 30′	154° 25′ W.	11.ix.51	219	683	2						26										4			×								
50	37° 28′	154° 12′ W.	12.ix.51	217	754																1				×								
53	33° 30′	153° 05′ W.	14.ix.51	221	724	2		6					1		1	1					1				×		2				2		
54^{17}	31° 58′	152° 25′ W.	15.ix.51	211	736	2		1	2			7	1			3				1	1		1		×	1	1						
55	30° 03′	152° 00′ W.	15.ix.51	208	772	5		22			1		1												×	1	1				1		
56	28° 06·5′	151° 25′ W.	16.ix.51	210	738	3		1	1		4	2			1	4									×	2	2		1		3	1	
57	29° 03′	149° 17′ W.	17.ix.51	215	793	1						7			1	1					1				×		3		1		1	1	
58	29° 45′	147° 05′ W.	18.ix.51	215	765	1		4				4				1				1				2	×	1	1						
59	30° 25′	145° 08′ W.	18.ix.51	220	714	3		1			2	4													×	2	2						
60	31° 19′	143° 02′ W.	19.ix.51	207	740	3		2	1				1	1	1	3				1					×		6		1		1		
61	32° 02′	140° 55′ W.	20.ix.51	198	768	3		2					1			3	1			1	1			1	×		2		5				
62	32° 46′	138° 50′ W.	20.ix.51	219	677	2		2								2			1					1	×	4	8				1		
63	33° 03′	136° 22·5′ W.	21.ix.51	206	803	7					4		1		1	5			1	2	1				×		9				1		
64	32° 53′	134° 13′ W	21.ix.51	197	756	5			1		3		1		2				1					1	×	4	3				1		
65	32° 52′	131° 58′ W	22.ix.51	181	817							15					1								×		6						
66^{17}	32° 39′	129° 41′ W	23.ix.51	208	810	53										1									×		2				1		

TABLE I—*contd.*

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m³)	*Tomopteris elegans*	*Tomopteris septentrionalis*	*Tomopteris planktonis*	*Tomopteris ligulata*	*Tomopteris nisseni*	*Tomopteris apsteini*	*Tomopteris* not identifiable	*Naiades cantrainii*	*Vanadis formosa*	*Vanadis crystallina*	*Vanadis minuta*	*Vanadis longissima*	*Vanadis tagensis*	*Rhynchonerella gracilis*	*Rhynchonerella mobii*	*Rhynchonerella petersii*	*Rhynchonerella angelini*	*Plotohelmis tenuis*	*Krohnia lepidota*	*Alciopid fragments*	*Typhloscolex mülleri*	*Sagitella kowalewskii*	*Travisiopsis lobifera*	*Lopadorhynchus brevis*	*Lopadorhynchus uncinatus*	*Lopadorhynchus krohnii*	*Pelagobia longicirrata*	*Maupasia caeca*
		CHINOOK EXPEDITION																															
1	28° 42·3′	151° 47·2′ W.	8.vii.56	91	555	1		2				8			1									2	×	1	9			2	1		
2	32° 38′	154° 49·5′ W.	11.vii.56	130	472	1			1			10	1			1	1			2					×		8				2		
3	39° 56·3′	158° 38·5′ W.	15.vii.56	115	536							72									2				×			1					
4	42° 33′	162° 09′ W.	17.vii.56	100	498	10	6					42									1				×	13							
5	47° 01′	164° 55·5′ W.	19.vii.56	100	509																												
7	46° 28·3′	174° 29·3′ W.	31.vii.56	100	526		4					10														8		2					
8	40° 28′	173° 04′ W.	3.viii.56	100	523	1	2																			1	3	1			1		
9[17]	32° 37·6′	172° 21·3′ W.	6.viii.56	94	573	2					4		1								1		1	1	×	14	5		1		4	2	
		P.O.F.I. *Hugh M. Smith* CRUISE No. 30																															
26	38° 48′	179° 52′ W.	28.vii.55	140	not known								1			1									×								
29	41° 50′	179° 54′ W.	29.vii.55	140	,,												1											1					
32	44° 56′	179° 49′ W.	30.vii.55	140	,,							14																1					
44	45° 05′	172° 30′ W.	4.viii.55	140	,,																												
46	43° 20′	172° 19′ W.	4.viii.55	140	,,							1										1					1						
70	37° 30′	164° 48′ W.	13.viii.55	140	,,							16	1																				
71	38° 59′	164° 50′ W.	14.viii.55	140	,,							4	2		1	1						4			×								
73	40° 28′	165° 00′ W.	14.viii.55	140	,,							17			1						1	1			×	1							
74	42° 03′	164° 52′ W.	15.viii.55	140	,,	1						40					2						1		×	1		1					
76	43° 29′	165° 02′ W.	15.viii.55	140	,,							11																					
77	44° 57′	165° 01′ W.	16.viii.55	140	,,																							1					
79	46° 29′	164° 56′ W.	16.viii.55	140	,,		49					67														1	1						
87	48° 04′	157° 24′ W.	20.viii.55	140	,,							8																					
89	46° 28′	157° 06′ W.	20.viii.55	140	,,							1														2	1	1					
90	44° 57′	157° 26′ W.	21.viii.55	140	,,		2					10														1							

TABLE I—*contd.*

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m³)	*Tomopteris elegans*	*Tomopteris septentrionalis*	*Tomopteris planktonis*	*Tomopteris ligulata*	*Tomopteris nisseni*	*Tomopteris apsteini*	*Tomopteris* not identifiable	*Naiades cantrainii*	*Vanadis formosa*	*Vanadis crystallina*	*Vanadis minuta*	*Vanadis longissima*	*Vanadis tagensis*	*Rhynchonerella gracilis*	*Rhynchonerella mobii*	*Rhynchonerella petersii*	*Rhynchonerella angelini*	*Plotohelmis tenuis*	*Krohnia lepidota*	*Alciopid* fragments	*Typhloscolex mülleri*	*Sagitella kowalewskii*	*Travisiopsis lobifera*	*Lopadorhynchus brevis*	*Lopadorhynchus uncinatus*	*Lopadorhynchus krohnii*	*Pelagobia longicirrata*	*Maupasia caeca*
93	43° 23′	157° 24′ W.	21.viii.55	140	not known							62									1				×								
94	41° 56′	157° 22′ W.	22.viii.55	140	,,							171																					
96	40° 27′	157° 31′ W.	22.viii.55	140	,,	90											1				2				×							7	
97	38° 57′	157° 30′ W.	23.viii.55	140	,,							16																					
99	37° 26′	157° 30′ W.	23.viii.55	140	,,	5						4	1		2	1									×				1	1			
100	35° 56′	157° 30′ W.	24.viii.55	140	,,								1			2																	
102	34° 28′	157° 30′ W.	24.viii.55	140	,,	2			2				6		2	3					1				×		1						

[1] 1 *Pedinosoma curtum.*
[2] 1 *Travisiopsis levinseni.*
[3] Quarter of sample examioed.
[4] 4 *Travisiopsss levinseni* : ½ of the sample examined.
[5] 3 : 2 : 3 *Travisiopsis lanceolata* respectively.
[6] 1 : 2 : 2 *Tomopteris pacifica* respectively.
[7] Three-quarters of the sample examined.
[8] 1 *Travisiopsis lanceolata.*
[9] 1 : 6 : 1 : 1 : 3 *Travisiopsis dubia* respectively.
[10] 1 *Travisiapsis lanceolata.*
[11] 1 *Travisiopsis levinseni.*
[12] All 1 specimen of *Pedinosoma curtum* except 141A (2).
[13] 53 specimens of *Phalacrophorus uniformis.*
[14] 1 *Phalacrophorus pictus.*
[15] 1 *Pedinoson a curtum.*
At Northern Holiday Stn. 51, 36° 12·5 N., 153° 56 W., the net was torn, 1 specimen of *Naiades cantrasnii* and some Alciopid fragments were present.
[16] Half of the sample examined.
[17] 1 *Travisiopsis lanceolagta.*
[18] 2 *Travisiopsis dubia*

TABLE II.—*Species Collected at Stations in the Sub-Arctic Zone*

TRANS-PACIFIC EXPEDITION

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m^3.)	*Tomopteris septentrionalis*	*Tomopteris pacifica*	*Tomopteris* not identifiable	*Rhynchonerella angelini*	*Alciopid* fragments	*Typhloscolex mülleri*	*Pelagobia longicirrata*	*Phalacrophorus pictus*
19A	48° 14·2′	153° 20·1′ W.	6.viii.53	0–129	447	1		23			12		
B	,,	,,	,,	164–282	332	9	10		1		16		
20A	49° 29·5′	154° 56·5′ W.	7.viii.53	0–153	451	1		31			37		
B	,,	,,	,,	153–324	526	8	2	36			20		
21A	50° 25·0′	156° 37·0′ W.	8.viii.53	0–137	439	2		38			13		
B	,,	,,	,,	0–115	1,277	3		156			30		
C	,,	,,	,,	0–288	1,050	158	5	143			30	3	3
22A	51° 21·3′	158° 20·0′ W.	8.viii.53	0–129	479			8			7		
B	,,	,,	,,	0–294	1,077	5		28			11		
23A	52° 10·4′	160° 08·0′ W.	9.viii.53	0–135	535	17		59			10		3
B	,,	,,	,,	0–270	1,095	78	1	21			12		
24A	53° 15·0′	161° 55·0′ W.	9.viii.53	0–180	417			13					
B	,,	,,	,,	135–270	351	7				×	27	2	4
C	,,	,,	,,	288–637	462					×	7	34	3
25A	53° 32·5′	163° 20·8′ W.	10.viii.53	0–84	514	1		4					
B	,,	,,	,,	137–318	351	55		4			4	12	1
C	,,	,,	,,	270–594	464		1	7			3	4	1
D	,,	,,	,,	525–1,175	1,860			11			2	105	
26A[1]	54° 00·0′	168° 19·8′ W.	13.viii.53	0–100	305	12					11		
27A	54° 00·0′	170° 03·0′ W.	13.viii.53	0–132	524			45			20		
B[1]	,,	,,	,,	149–265	175	12					14		7
28A	53° 50·5′	171° 40·0′ W.	13.viii.53	0–145	433	18		5			4		1
B[2]	,,	,,	,,	0–295	852	86	1				9		
29A[1]	54° 00·0′	173° 15·5′ W.	14.viii.53	0–180	262			10			3		
B[1]	,,	,,	,,	165–360	166	5					8	1	9
C[1]	,,	,,	,,	305–460	277					×	7	8	14
30A	53° 57·7′	175° 04·5′ W.	15.viii.53	0–125	433			1			5		
B[1]	,,	,,	,,	0–300	472	3		10			6	1	
31A	53° 15·6′	175° 37·6′ W.	15.viii.53	0–105	439						10		
B	,,	,,	,,	130–265	555	38		7			29		1
32A	52° 29·3′	176° 09·0′ W.	15.viii.53	0–105	543	2		20			7		8
B	,,	,,	,,	115–265	370						4	1	
C	,,	,,	,,	300–515	520						2	22	2
33A	52° 19·9′	176° 57·5′ W.	24.viii.53	0–125	478			4			3		2
B[2]	,,	,,	,,	120–305	333		1				8		
34A	53° 10·3′	177° 59·0′ W.	25.viii.53	0–180	469	1		20			11		
B[2]	,,	,,	,,	0–320	780	2					7		1
35A[3]	54° 05·5′	178° 56·2′ W.	25.viii.53	0–395	216	1	1	21			7		
36A	54° 00·9′	178° 58·7′ E.	26.viii.53	0–165	381	2					14		
B	,,	,,	,,	0–290	787	30				×	77		
37A	53° 59·0′	176° 55·0′ E.	27.viii.53	0–140	400	14		30			67		
B	,,	,,	,,	0–290	914	56		10		×	104		5

[1] Half of the sample examined.
[2] Quarter of the sample examined.
[3] Eighth of the sample examined.

TABLE II.—*contd.*

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m³.)	*Tomopteris septentrionalis*	*Tomopteris pacifica*	*Tomopteris* not identifiable	*Rhynchonerella angelini*	*Alciopid* fragments	*Typhloscolex mülleri*	*Pelagobia longicirrata*	*Phalacrophorus pictus*	*Maupasia caeca*
38A[2]	53° 59·1′	174° 49·0′ E.	28.viii.53	0–165	107	3								
B	,,	,,	,,	145–320	212	77	2				8		6	
39A	54° 03·1′	172° 28·8′ E.	30.viii.53	0–180	412			12			26			
B	,,	,,	,,	160–335	350	6	1				11	7	1	
40A	53° 57·0′	171° 10·8′ E.	30.viii.53	0–170	422	29					1			
B	,,	,,	,,	170–340	261		2				24	10		
C	,,	,,	,,	340–510	335						3	65		
D	,,	,,	,,	510–680	340							38		
E	,,	,,	30–31.viii.53	0–1,020	620	58	1	6			10	6		
41A	53° 32·1′	168° 50·8′ E.	31.viii.53	0–135	526	8					3			
B	,,	,,	,,	140–290	370	26	1				15	6		
42A	53° 32·4′	176° 10·8′ E.	1.ix.53	0–175	750	4					73			
B	,,	,,	,,	175–350	695	42			1		44			
C	,,	,,	,,	350–525	670	1					6	62		1
E	,,	,,	,,	0–1,050	587	21			1		15	45		
43A	53° 35·5′	173° 42·0′ E.	1.ix.53	0–155	402	4					14			
B	,,	,,	1–2.ix.53	0–325	1,043	10	1			×	20	5		
44A	53° 40·8′	161° 55·5′ E.	2.ix.53	0–170	482	20		28			13			
B	,,	,,	,,	155–335	351	20					30		4	
C	,,	,,	,,	320–565	462	2					7	46	1	
45A	52° 23·0′	163° 15·2′ E.	3.ix.53	0–35	277									
B	,,	,,	,,	0–105	498						6			
C	,,	,,	,,	40–145	259			1			20			
D	,,	,,	,,	150–300	425	54					36			
46A	51° 13·0′	164° 34·3′ E.	4.ix.53	0–170	1,010	19			1		8			
B	,,	,,	,,	170–340	740		4		1		30	2	2	
C	,,	,,	,,	340–510	720			4			16	52		
D	,,	,,	3–4.ix.53	0–1,015	4,165	25		5		×	6	4		
47A	49° 50·1′	165° 49·2′ E.	5.ix.53	0–20	267	2		20						
B	,,	,,	,,	0–155	567	15		53			6		1	
C	,,	,,	,,	35–150	166	2	1				2			
D	,,	,,	,,	160–275	499			1			15	11		
48A	48° 46·3′	166° 48·1′ E.	5.ix.53	0–25	163									
B	,,	,,	,,	0–100	500	19		21			35			
C	,,	,,	,,	35–115	278	5					36			
D[4]	,,	,,	,,	140–320	475	19					9	7		
49A	47° 35·7′	167° 44·8′ E.	6.ix.53	0–170	788	4		64			19			
B	,,	,,	,,	170–340	760	45	1				11		4	
C	,,	,,	,,	340–510	760						1	5		
D	,,	,,	,,	510–680	760							38		
E[5]	,,	,,	,,	0–1,015	359	1		65	1		6	12		
50A	46° 16·5′	168° 52·2′ E.	6.ix.53	0–145	478	16		19			10			
B[5]	,,	,,	,,	155–355	370	3	3	2	1		9	1		1
61A	45° 15·1′	158° 20·0′ E.	14.ix.53	0–129	527	15					18			
B[6]	,,	,,	,,	135–270	1,130	5		17	4	×	11			
C	,,	,,	,,	270–446	558		1	5	1		6	21		
62A	45° 57·8′	156° 52·5′ E.	14.ix.53	0–106	490	3		2			19			
B	,,	,,	,,	0–258	1,086	25					23			

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[4] 1 *Rhynchonerella gracilis.*

[5] One tenth sample examined.

[6] 1 *Plotohelmis tenuis.* One *Sagitella kowalewskii* at Stn. 50B.

TABLE II.—*contd.*

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m^3.)	*Tomopteris septentrionalis*	*Tomopteris pacifica*	*Tomopteris* not identifiable	*Rhynchonerella angelini*	*Alciopid* fragments	*Typhloscolex mulleri*	*Pelagobia longicirrata*	*Phalacrophorus pictus*	*Maupasia caeca*
63A	46° 23·5′	155° 28·6′ E.	15.ix.53	0–129	545			3			4			
B	,,	,,	,,	135–270	408			5			27		1	
C	,,	,,	,,	270–374	685	25	1				30	9	1	
64A	46° 54·5′	153° 55·2′ E.	15.ix.53	0–157	436	18					36			
B	,,	,,	,,	75–318	444	19					23		1	
65A	45° 29·9′	154° 19·7′ E.	16.ix.53	0–124	500			2			3			
B	,,	,,	,,	147–340	1,166	4					37	1		
66A	44° 09·0′	152° 56·8′ E.	17.ix.53	0–168	529	12		20			67			
C	,,	,,	,,	276–506	814	1					1			
E	,,	,,	,,	0–1,020	3,810	4	2	109			15	10		
66A[1]	,,	,,	,,	0–700	300			210	1		17	36		
67A	43° 09·0′	151° 52·0′ E.	18.ix.53	0–97	583			9			8			
B	,,	,,	,,	0–176	1,118	14		4			20			
68A	42° 02·2′	150° 33·2′ E.	18.ix.53	0–103	490			42			8			
B	,,	,,	,,	132–276	407	28					32			
69A	40° 54·5′	149° 25·7′ E.	19.ix.53	0–141	465			24			1			
71A	40° 05·0′	146° 45·0′ E.	20.ix.53	0–28	276									
B	,,	,,	,,	0–132	445	2		7			5			
C	,,	,,	,,	135–270	444			35			17			1
72A	40° 25·3′	145° 29·3′ E.	20.ix.53	0–41	189			2						
B	,,	,,	,,	0–115	464	3		6			1			
C[8]	,,	,,	,,	153–270	370	16		24			21			
73A	40° 53·4′	143° 51·5′ E.	21.ix.53	0–40	352									
B	,,	,,	,,	0–141	435			8			1			
C	,,	,,	,,	173–390	1,128	1		1			18			
78A	37° 58·9′	146° 01·1′ E.	30.ix.53	0–141	473	3		13						
B	,,	,,	,,	160–330	370	1		13			2			
		NORTHERN HOLIDAY EXPEDITION												
19	48° 48′	150° 00′ W.	14.viii.51	118	1,143	1					15			
21	51° 35′	149° 52′ W.	15.viii.51	222	669	2					7			
22a	52° 50′	149° 52′ W.	16.viii.51	205	715	10					9			
23	56° 28·5′	151° 39′ W.	29.viii.51	206	796	9					5			
24	55° 50′	151° 18′ W.	29.viii.51	200	847	8	1	20			5			
25	54° 52′	150° 53·5′ W.	30.viii.51	188	834	31					2			
26[7]	54° 08′	150° 23′ W.	30.viii.51	222	688	29		27	1		27			
27	53° 13′	149° 56′ W.	31.viii.51	182	759	22					1			
28	53° 13′	157° 36′ W.	31.viii.51	203	751	1					1			
29	53° 24·5′	153° 18′ W.	1.ix.51	227	693						5			
30	53° 34·5′	155° 00′ W.	1.ix.51	202	665	8					4			

[7] 1 *Rhynchonerella gracilis.*
[8] 1 *Travisiopsis lanceolata.*

Stn. No.	Latitude (N.)	Longitude	Date (local)	Depth (m.)	Volume water filtered (m^3.)	*Tomopteris septentrionalis*	*Tomopteris pacifica*	*Tomopteris* not identifiable	*Rhynchonerella angelini*	*Alciopid* fragments	*Typhloscolex mulleri*	*Pelagobia longicirrata*	*Phalacrophorus pictus*	*Maupasia caeca*
31	54° 00′	156° 32′ W.	2.ix.51	219	668	21	1				7	1	1	
32	54° 18′	157° 58′ W.	2.ix.51	188	765	11					2			
36	51° 00′	158° 33′ W.	4.ix.51	182	887	37		10			3			
37	50° 01′	158° 16′ W.	5.ix.51	160	1,004	56		7			2			
38	49° 01′	157° 55′ W.	5.ix.51	189	788	32		4			37			
39	48° 06·5′	157° 27′ W.	6.ix.51	204	704	25					13			
40	47° 05·5′	157° 16′ W.	7.ix.51	214	703	10	1				4			
CHINOOK EXPEDITION														
6	50° 21′	178° 36′ W.	29.vii.56	85	565	35					18			
P.O.F.I. *Hugh M. Smith* CRUISE NO. 30														
37	49° 34′	179° 58′ W.	31.vii.55	145	Not known	46		8						
80	48° 07′	164° 55′ W.	17.viii.55	139	,,									
81	49° 29′	165° 00′ W.	17.viii.55	140	,,			4			4			
83	49° 42′	162° 25′ W.	18.viii.55	137	,,	1		16						
84	49° 48′	159° 40′ W.	19.viii.55	141	,,			12			3			
86	49° 35′	157° 22′ W.	19.viii.55	139	,,	1		18						

TABLE III.—*Collections of the University of Washington, Dept. of Oceanography*

Cruise BB—199—M.W.T.

St.	Position		Date	Species collected (and number of specimens)
	N.	W.		
20	48° 46·8′	129° 58·8′	2.vii.58	*Rhynchonerella angelini* (1).
30	49° 02·6′	133° 39·5′	4.vii.58	*Plotohelmis tenuis* (3).
34	49° 09·3′	134° 57·2′	4.vii.58	*Plotohelmis tenuis* (1).
55	49° 23·1′	140° 24·8′	7.vii.58	*Tomopteris septentrionalis* (1).
64	49° 36·9′	142° 45·9′	8.vii.58	*Tomopteris pacifica* (1).
75	49° 48·2′	145° 27·9′	9.vii.58	*Travisiopsis lobifera* (1).
80	49° 30·1′	145° 52·5′	9–10.vii.58	*Tomopteris pacifica* (1).
99	45° 41·5′	146° 25·4′	12.vii.58	*Tomopteris septentrionalis* (1).
110	43° 42·0′	146° 25·0′	13.vii.58	*Tomopteris elegans* (1).
115	42° 47·2′	145° 20·1′	14.vii.58	*Tomopteris elegans* (2).
128	40° 35·8′	142° 54·5′	15.vii.58	*Rhynchonerella angelini* (1).
136	39° 35·1′	141° 53·0′	16.vii.58	*Rhynchonerella angelini* (1).
137	38° 41·0′	141° 01·0′	16.vii.58	*Rhynchonerella angelini* (1).
138	38° 35·7′	140° 56·0′	16.vii.58	*Rhynchonerella angelini* (1).
140	38° 24·9′	139° 37·1′	17.vii.58	*Rhynchonerella angelini* (1).
144	38° 45·7′	138° 08·0′	17–18.vii.58	*Rhynchonerella angelini* (1).
150	39° 21·0′	136° 21·2′	18.vii.58	*Rhynchonerella angelini* (3).
151	39° 23·1′	136° 13·1′	18.vii.58	*Naiades cantrainii* (1).
153	39° 35·5′	135° 28·7′	18–19.vii.58	*Rhynchonerella angelini* (4).
157	39° 42·5′	135° 03·9′	19.vii.58	*Naiades cantrainii* (1).
158	39° 44·7′	134° 51·1′	19.vii.58	*Rhynchonerella angelini* (2).
159	39° 46·9′	134° 48·0′	19.vii.58	*Rhynchonerella angelini* (1).
160	40° 11·0′	133° 26·6′	19.vii.58	*Rhynchonerella angelini* (3).
161	40° 11·0′	133° 26·6′	19.vii.58	*Rhynchonerella angelini* (1).
167	40° 22′9′	131° 32·0′	20.vii.58	*Tomopteris elegans* (1).
171	39° 58·9′	130° 34·5′	21.vii.58	*Tomopteris elegans* (1).
172	39° 57·6′	130° 28·7′	21.vii.58	*Travisiopsis lobifera* (1).
173	39° 56·3′	130° 22·8′	21.vii.58	*Travisiopsis lobifera* (1).
174	39° 55·0′	130° 17·4′	21.vii.58	*Tomopteris elegans* (2).
179	38° 38·2′	125° 48·6′	23.vii.58	*Tomopteris septentrionalis* (1).
191	36° 40·0′	123° 21·0′	27.vii.58	*Travisiopsis lobifera* (1).
196	34° 49·0′	121° 03·5′	28.vii.58	*Tomopteris septentrionalis* (1).
228	33° 44·8′	125° 01·3′	3.viii.58	*Tomopteris elegans* (1).
235	33° 34·0′	126° 35·1′	4.viii.58	*Vanadis crystallina* (1).
241	32° 15·1′	128° 32·9′	4.viii.58	*Lopadorhynchus uncinatus* (1).
249	35° 02·5′	130° 08·8′	6–7.viii.58	*Tomopteris elegans* (1).
252	35° 10·1′	130° 11·9′	7.viii.58	*Tomopteris elegans* (2).
253	35° 13·1′	130° 12·7′	7.viii.58	*Rhynchonerella mobii* (1).
256	36° 44·3′	130° 51·0′	7–8.viii.58	*Lopadorhynchus uncinatus* (1). *Vanadis formosa* (1). *Rhynchonerella angelini* (1).
257	36° 47·9′	130° 52·9′	8.viii.58	*Naiades cantrainii* (1).
258	36° 51·8′	130° 54·3′	8.viii.58	*Naiades cantrainii* (1).
261	37° 03·4′	130° 58·5′	8.viii.58	*Rhynchonerella angelini* (1).
263	39° 19·8′	131° 48·6′	8–9.viii.58	*Rhynchonerella angelini* (1).

TABLE III.—*cont.*

St.	Position N.	 W.	Date	Species collected (and number of specimens)
264	39° 24·3′	131° 50·2′	9.viii.58	*Rhynchonerella angelini* (4). *Naiades cantrainii* (1).
266	39° 32·0′	131° 53·0′	9.viii.58	*Vanadis formosa* (1). *Vanadis longissima* (2).
268	39° 40·9′	131° 56·3′	9.viii.58	*Rhynchonerella angelini* (7).
275	41° 16·0′	133° 13·3′	10.viii.58	*Vanadis longissima* (1). *Rhynchonerella angelini* (2).
277	42° 41·8′	135° 17·0′	10–11.viii.58	*Rhynchonerella angelini* (1).
284	45° 10·5′	139° 27·2′	12.viii.58	*Tomopteris elegans* (1).
			Cruise BB—202—MWT	
9	49° 52·8′	130° 30·0′	23.ix.58	*Travisiopsis lobifera* (1).
50	47° 52·1′	134° 28·2′	29.ix.58	*Tomopteris septentrionalis* (1).
71	47° 56·0′	128° 14·3′	1.x.58	*Tomopteris septentrionalis* (1).

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ADDENDA.

The International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology (1961) was published after this paper was in page proof and it has not therefore, been possible to incorporate the necessary alterations into the text but they are listed below—

For *Typhloscolex mülleri* read
Typhloscolex muelleri—Articles 27 and 32 (c) (i).
For *Rhynchonerella petersii* read
Rhynchonerella petersi—Article 31.
For *Lopadorhynchus krohnii* read
Lopadorhynchus krohni—Article 31.

23 FEB 1962
PRESENTED.

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